A METHODOLOGY TO DETERMINE FACTORS FOR SELECTING TRAINING SCENARIOS IN VIRTUAL AND CONSTRUCTIVE SIMULATIONS

by

BRIAN P. BEDELL
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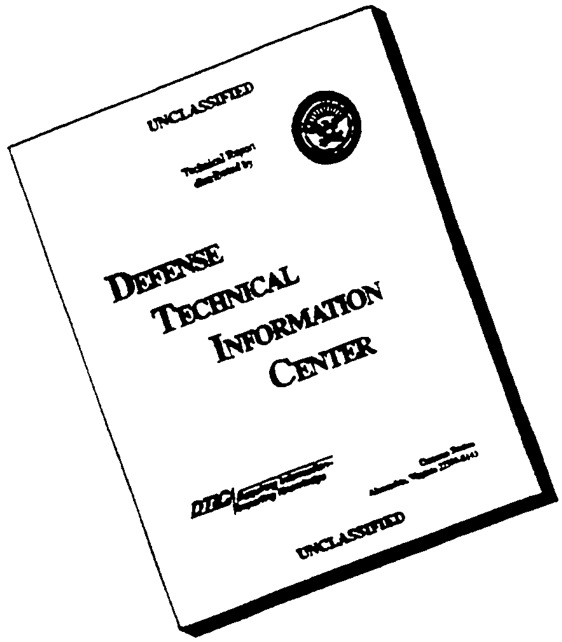

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ABSTRACT

This research develops and demonstrates the use of a Preference-Characteristic methodology to select between scenarios for the purpose of training a unit in a virtual or constructive environment. The methodology proved successful though additional research will be required before the tool can become fully operational.

The effort to exploit the potential of simulation for improving task proficiency began in the early 1970's. Technology at the time limited most efforts to improvements in live simulation training. In 1973 the Constructive Tactical Engagement System (TES) was the first Army organizational computer based simulation training device.

The advancement in technology and the successful use of these initial training tools lead to the expansion of simulation training devices. Along with the explosion of computer based simulations was an order of magnitude explosion in the number of training scenarios. The number of scenarios became so unwieldy that numerous governmental review boards recommended that efforts be made to catalog them and place them in libraries.

To solve this problem the Army developed exercise development tools to serve the diverse training population. This research effort refines that process. The geographic dispersion of the users and limited resources mandated the use of a survey as a collection tool. The survey was conducted in two phases: 1) an informal pilot phase used to develop and refine the survey instrument along with analysis techniques and 2) a formal pilot test where members of the targeted populations were solicited for their responses.

Two types of statistical analysis were applied to the data, mean based and frequency based. The outcome of the analyses was a weight matrix that quantified the impact each selection factor imposed on the decision. The quantified data can then be applied through a mathematical model that uses these weights to differentiate between previously equivalently ranked alternatives. An automated search was accomplished by quantifying the characteristics of the scenarios and the users preferences against the same criteria. Simple mathematics and matrix comparisons and calculations were then be used to quantify the level of agreement between the scenarios and the users preferences. An automated example of the selection methodology demonstrates and yields a correct solution.

The methodology developed in the study can be applied to any scenario selection process. Only the codification and knowledge acquisition are domain dependent.

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Introduction

"Everything is simulation except combat."
Defense Science Board, 1993

All skill training that takes place apart from the environment in which it will be utilized is simulation. The purpose of the training exercise is not important. A salesman rehearsing his pitch about a new car model and a tank gunner engaging targets in a virtual environment are both honing their skills in an effort to improve their levels of performance. They can improve their level of proficiency through the repetition of their tasks in an environment that supplies the same cues as the real world. Both are training with simulation.

"Large scale maneuvers are a thing of the past.... The ecologists will make you stop fighting if you raise too much dust."
General W. E. Depuy, 1973

Recognizing the impact of mounted maneuver exercises on the environment, General Depuy's made this statement as the U.S. Army began a massive drawdown in strength. These comments were not made after the fall of the Berlin Wall in the late 1980's but in 1973 as the United States moved from a conscription military to an all volunteer force (Gorman, The Secret of Future Victories, 1992). As the Chief of Staff of the Army in 1971, General Westmoreland had created the Board For Dynamic Training (BFDT) (Gorman, 1992). Westmoreland established the BFDT with the mandate to design realistic military training that compensated for the shortages of firing and maneuver ranges and ammunition while maximizing soldiers' safety and minimizing cost and environmental impact. The BFDT accomplished its mission by designing Tactical Engagement Simulations (TES) which supported maneuver training and battle simulations which supported the decision making process.

BFDT's successor, the Combat Arms Training Board, developed TES systems for live simulation training. The first successful fielded systems were SCOPES (not an acronym) and REALTRAIN (not an acronym) (Orlansky, The Value of Simulation Training, 1994). SCOPES used a rifle mounted optical sight and a number attached to each soldier's helmet. The system assessed a "kill" when the firing soldier could read the target's number. REALTRAIN was a similar system developed for mounted combat training. These systems led to the development of the Multiple Integrated Laser Engagement System (MILES) which was distributed throughout the Army in the early

1980's as the primary training device for the simulations conducted at the Combat Training Centers (CTC's).

The constructive simulations did not really advance until the 1973 Arab-Israeli war (Gorman, The Military Value of Training, 1990). The Army studied how Israel fought outnumbered and won. This battle simulation, constructive TES, was the forerunner of the computer simulations used for analysis and command post exercises today.

As the commander of The U.S. Army's Training and Doctrine Command (TRADOC), General Depuy asserted that simulation-based training (primarily TES) was important in that it trained the soldiers to function as teams. The gains achieved in teamwork and synchronization were far more important than improvement in individual skills. The U.S. Army currently recognizes that training in simulation benefits both performance and "the evaluation of concepts, the evaluation of weapon systems, supply [strategies], tactics and doctrine." (Orlansky, 1994)

Simulation Training Today

Although some overlap does occur, the U.S. Army groups simulation training into four categories: live simulation, virtual simulation, constructive simulation and distributed simulation.

Live simulation involves operations with actual units and equipment in real space under as close to battle conditions as possible (Piplani et al, Systems Acquisition Manager's Guide for the Use of Models and Simulations, 1994). The training location maximizes the soldiers' ability to practice the tactics, techniques, and procedures that will ensure unit success in combat. The soldiers' actions are monitored, adjudicated, and evaluated using the tools of live simulation. Systems such as the Multiple Integrated Laser Engagement System (MILES), the Tank Weapons Gunnery Simulation System (TWGSS), and instrumented ranges monitor the unit's progress and provide feedback.

Like live simulations, virtual simulations immerse individuals and crews in a realistic training environments designed to replicate combat. Virtual simulation differs in that first and foremost the environment is a computer generated or enhanced battlefield that is sensed or visualized by the trainee. The trainee then interacts with this environment via high fidelity representations of equipment. The simulation attempts to replicate the trainees' (usually a crew of a combat vehicle or weapon system) equipment and external environment as much as possible. Crew actions cause the simulator to interact with its virtual world as the real vehicle would interact in the real world. Thus, the crew can train on individual and collective tasks as well as battlefield synchronization. The best examples of virtual trainers are the M1 Tank Driver Trainer, the Unit Conduct of Fire Trainer (UCOFT), and aircraft pilot trainers.

Constructive simulations are complex, deterministic and stochastic computer driven models used to train commanders and their staffs to monitor, evaluate and develop

the battle. In a constructive simulation the battle space and the player entities exist entirely within the computer. The primary audience of trainees are usually isolated from this constructed computer simulation world by organic decision support systems. Maneuver, attrition, and supply algorithms simulate the actions of real units in the training. Computer operators interact with the constructive simulation's computer interfaces to generate the reports that track the flow of the battle. Some of the most widely used constructive simulations in the Army are Janus, Battalion/Brigade Battle Simulation (BBS), and the Corps Battle Simulation (CBS).

Blurring the boundaries between live, virtual, and constructive simulation, Distributed Interactive Simulations (DIS) facilitate the linking of all forms of simulation. This linking can occur at any scale. Examples are the integration of two individual training simulations located in the same room connected via a local area network (LAN) or the linking of large units geographically-dispersed over a wide area using dedicated communications linkages to train higher level staffs (Hollenbach, 1995). In the distributed simulations, constructive entities can interact with manned virtual entities. Live entities operate within their own environment, but can be acted upon by virtual or constructive entities. The integration of different simulations allows the scaling of the training audience. Individuals, teams, and units can all interact in the same battle space through live, virtual, and constructive means. The ability to integrate across simulation environments and certain simulators is very dependent on the architecture used to

transfer and trace data in the form of Protocol Data Units (PDU's) in the simulations (Brann, 1995) (Hollenbach, 1995).

The Simulation Networking Trainer (SIMNET) and the Combined Arms Tactical Trainer (CATT) family are examples of distributed simulations whose interface and distributed nature is so transparent to the trainee that the simulation appears to be virtual. The immersive virtual nature of the individual simulators causes the users to consider the trainers to be virtual simulator systems.

This paper seizes on the overwhelming virtual appearance these simulators present to their training audience and includes them when referring to virtual simulations.

Training

The U.S. Army's simulation programs are integrated into its overall training plan. All training in the Army begins with an assessment of the unit's proficiency based on the unit's Mission Essential Task List (Headquarters the Department of the Army (HQDA), 1990). The Mission Essential Task List (METL) is a list of the critical wartime functions for the unit. Each unit is rated on each task in terms of being trained, needing practice, and being untrained. This process gives the commander a list of tasks on which his unit must either sustain or improve their performance.

The unit commander and staff then incorporate the higher commander's guidance along with the status and availability of several factors (e.g., training audience, training objectives, risk assessment, and available resources). In simulation-based training, the

commander must also assess the availability of Training Aids, Devices, Simulators and Systems (TADSS) and then determine which training scenarios for the particular simulation system would best support the execution of the training (HQDA, , 1996). The commander ensures that the training scenario replicates the appropriate conditions and standards that the unit will encounter in combat (U.S. Army Research Institute (ARI), 1993).

The Effects of Virtual and Constructive Simulation Training in the U.S. Army

The Army has garnered great improvements in its operational readiness from the inclusion of virtual and constructive simulation based training. Simulator-based training provides:

- Excellent immediate or short delay feedback
- The opportunity to repeat situations that were not completed successfully
- The flexibility to modify training situations
- Great reduction in resource expenditure and risk (Orlansky, 1994).

The trainee receives prompt and accurate feedback because of the computer based nature of virtual and constructive simulations. The crew manning a tank in a virtual battle receives feedback on their performance as they maneuver. If they receive enemy fire, they learn that they exposed themselves; if they fail to maintain their place in formation they can view this problem when the battle is replayed. Similarly, constructive simulations show a commander if the staff is capable of monitoring and interpreting the

course of the battle. Any poor decisions could result in abnormal loss ratios, untenable positions, or a commander's inaccurate perception of the battle.

Simulations offer the commander the ability to repeat tasks and scenarios that their forces have failed to master. If a unit makes a drastic mistake the trainer can simply reset the scenario to the start time. This allows the unit to learn from its mistakes while their errors are still fresh. Repeatability and immediate feedback are two of the most important keys to learning (Anderson, Rules of the Mind, 1993). In live simulations, the process of moving troops to their original locations could require lots of time. The re-setting of the live training scenario consumes valuable training time and resources; this consumption of time and resources takes away from the unit's opportunity to reinforce training.

The money saved in simulation training comes from three sources: the reduction in the use of vehicles, the savings associated with the repair of maneuver damage, and the simulator's life cycle costs (HQDA, Battle Focused Training, 1990). Some of the most significant savings occur in vehicle operation training simulators as indicated in Table 1.

TABLE 1 INCREMENTAL DIFFERENTIAL COST

Weapon System	Simulator Cost/(Unit)	System Cost/(Unit)
M1A1	$2.50/mile	$75.00/mile
UH-60	$59.00/hour	$1,448/hour
AH-64	$70.00/hour	$3,101/hour

(National Training Systems Association, 1997)

Huge savings can also be attained by applying virtual or constructive technologies to live simulations. In 1992 constructive and virtual constructs were applied to the annual Return of Forces to Germany (REFORGER) exercise. $34 million were saved as compared to an equivalent exercise that occurred in 1988 (ADPA, 1997).

There are also great costs associated with deploying maneuver forces to the training location. The excessive costs in terms of money, time and resources of moving equipment to large training areas by truck, rail or barge can consume training budgets. U.S. Army Combat Training Center Directorate breaks down of costs of a typical National Training Center (NTC) rotation of a Brigade Combat Team consisting of two Battalion Task Forces from Fort Riley Kansas follows in Table 2.

TABLE 2 NTC ROTATION BUDGET

Budget Item	Cost
Transportation of Personnel (4, 000)	$1.6 million
Transportation of equipment (Barge)	$800 thousand
Logistical base and supplies	$2.3 million
Training Cycle	$1.3 million
Total	**$6 million**

(Croteau, Telephone Interview, 1997)

In this example, 21% of the exercise budget is expended during the conduct of training. The majority of the training funds are spent gathering the players, their equipment, and the resources that will be consumed during the exercise. It is often difficult to coordinate units' arrivals. This leads to the consumption of additional resources.

It is also expensive to train and equip an Opposing Force (OPFOR). Beyond the costs associated with equipping the OPFOR with equipment that accurately depicts the form and capabilities of the threats weapons, one also has to support the infrastructure of an entire brigade that does not contribute to the Army's combat projection.

The savings in resources extends beyond funds. Simulation training compensates for limits on maneuver space, the gathering of forces, a lack of a trained OPFOR, and the inability to replicate the logistical battle (HQDA, Battle Focused Training, 1990). As General Depuy indicated in the early 1970's, the Army has limited land available for large maneuver forces. The National Training Center, at Fort Irwin, California is one of the few remaining training areas that can support brigade level live fire maneuver exercises. The majority of training areas can support only restricted battalion level operations.

Shortfalls of Simulation Training

In an effort to improve the quality of simulation based training, the U.S. Army has commissioned 26 reviews of its training simulation programs since the 1970's (Flectcher, A Review of Study Panel Recommendations For Defense Modeling and Simulation, 1992). Many of the recommendations focus on two areas concerning training scenario selections. Many of the boards recommended that the Army reduce the planning and support requirements needed to conduct simulation training and that libraries be established from which commanders can choose training scenarios.

The 1988 Report of the Defense Science Board Task Force on Computer Applications to Training and Wargaming (AD-A199 456) and the 1989 Wargaming Activities in the Department of Defense (Report NO. 89-057) both recommended reducing the burden associated with planning simulation based training (establishing scenarios, placement of forces, etc.). These studies found that there was a great deal of overhead associated with conducting training, particularly with Reserve Component (RC) units. The study stated that the benefit of the training is impacted by planning requirements and that the units' readiness would improve if the planning burden was reduced.

Several review boards have also recommended the establishment of data or archived file libraries to hold simulation data and exercises for use by the troops. The Army Science Board Final Report of the Ad Hoc Subgroup on the use of Army Combat Models for the Analysis and Training of Joint Combined Operations (AD-B120 937) and the 1989 Wargaming Activities in the Department of Defense both made this recommendation. The Army Science Board 1991 Summer Study on Army Simulation Strategy (Draft) further recommended that a catalog of certified and uncertified simulations and scenarios be established.

Other recommendations for changes include the 1988 Report of the Defense Science Board Task Force on Computer Applications to Training (AD-A199 456) and Wargaming's desire to integrate allied forces into scenarios so that U.S. commanders can train for multi-national operations. Dr. Larocque, Director of the National Simulation

Center at Ft. Leavenworth, Kansas, and the 101st Airborne Division's (Air Assault) Division Training Chief, Major Michael Rossi, both assert that work must be done to make the tools associated with planning simulation training more responsive to commanders. Both recommended that the selection should be based on mission, enemy, time, terrain, and troops (METT-T) considerations (Department of the Army, ARTEP 7-30-MTP, 1989).

A unit's METL is the Mission Essential Task List that is composed of the most important objectives the unit must be able to accomplish during war (Combined Arms and Service Staff School, Training Management. 1991). A sample METL for an infantry company (C company 1st battalion -27th Infantry Regiment (Wolfhounds) is composed of: Deploy, Assault, Move Tactically, Perform Reconnaissance, Defend, Occupy an Assembly Area, Perform Air Assault Conduct Non-combatant Evacuation Operations, Infiltrate/ Exfiltrate, Consolidate and Reorganize (Gubler, Personal Interview, 1996). Where the METL are the activities, METT-T are the conditions under which they are performed.

CHAPTER 2 PLANNING TOOLS AND A METHODOLOGY FOR IDENTIFYING COMMANDERS NEEDS

Current Approaches to Planning Training

Live Simulation

The majority of the collective training experience of the U.S. Army over the last 200 years has focused on live simulation. All of the training the U.S. Army conducted prior to the 1973 Arab-Israeli War were live simulations of combat. All training from the Continental Army's drills on the parade field during the Revolutionary War through the integration of SCOPES and REALTRAIN in the 1970's was live simulation. The U.S. Army's institutional training for the entire period was focused on maneuvering live forces on terrain replicating a real battlefield. This experience has led to a highly detailed Training Management planning process to gain the greatest benefit from the exercises.

Live simulations are also easily conceptualized by the training planners because they require concrete assets on land forms that are familiar to them. The training planners' life and work experience are in three-dimensional space. The wartime execution of the trained tasks is also going to be in three dimensional space (real world or real space). This is an important correlation for how the trainers visualize the training.

The military training planner functions within a formalized system of training

cycles (Combined Arms and Service Staff School, Training Management. 1991). Each U.S. Army battalion and brigade executes three training phases per quarter: post support, mission readiness, and prime training. The phase with the least amount of training is one of post support. During post support the unit's soldiers are used to support the other activities associated with the installation. This ranges from guarding ammunition storage facilities to supporting other unit's training activities. Post support is followed by a period of increased individual skill, weapon, and small unit training. During this period the unit's soldiers are trained and qualified with their weapons systems and the individual skills associated with their military occupational specialty. The unit's primary focus is on its ability to deploy and execute its war time mission. The final phase consists of rigorous collective task training. During this prime training phase the individual skills are integrated and synchronized. This often culminates in the evaluation of the unit at company, battalion, or brigade level.

This training phase structure affords the training planner the opportunity to conduct a leaders reconnaissance of training sites. At the site, the qualified trainer envisions the locations of units, their relative positions, and the movements of the elements during execution. Here the planners make decisions based on their experience and the training area.

This process involves the use of a multi- dimensional planar representation of the training area--a map. The map allows the planners to understand the relative positions of

the training areas. The map's depiction of the actual land forms is somewhat distorted. This distortion is based on scale and time. The scale distortion results from the compression of multi-dimensional topographical and cultural features onto a smaller, lesser dimensional tool. Decisions are made about the importance of objects based on their magnitude. Topographical features under selected sizes cannot be represented. Though this information may be essential at the tactical level, it may not be extractable from the map.

As a static representation of the terrain, a map's data does not reflect changes made since publication. Over time, the natural effects of erosion and man's impact on the terrain distance reality from the original representation. Natural events and man's actions render maps increasingly more inaccurate as time proceeds.

The impact of these distortions decreases as the primary training audience shifts from the company level to battalion and above . The importance of the placement of minor land forms at a unit or individual level decreases as the exercise includes larger groups. The impact is still felt locally by the elements involved at the site, but that impact is diluted at the larger scale.

The coordination of training resources and assets is also more easily understood in live training. The correct placement of assets and their need is most demonstrateable when their impact is visualized. The difficulty in maneuvering a tank that is equipped with a mine clearing plow over wooded terrain is more clearly understood when seen than when one simply acknowledges a reduced movement speed. The same effect is

noted when an event cannot take place because needed equipment is not in-place when required. The impact of trainees failing in their exercise is greater if the impact is direct and in real-time.

The impact in live simulation can be seen during a training exercise at the local training areas around any Army installation. A battalion task force training on defensive operations must notify its associated engineer company of what training tasks it wants to accomplish. The engineer assets are then moved to the training area. At the training area, the engineers are directed to help prepare defensive fortifications, lay mines and create obstacles. A properly prepared defense may take 72 or more hours to emplace. The defensive position is then defended.

At the end of the defense, the task force commander must decide if the unit needs to repeat any portion of the exercise, if another element must complete the same training, or if the exercise is completed.

If the unit needs to retrain on any of the defensive tasks it may be necessary to repeat the exercise. This could be accomplished on the same terrain or in another location. If either of these options are selected, the area of the defense must be returned to the its original condition in order to correct the problems that occurred in the last exercise or to make ready to move to a new area. If the retraining is to occur at the same location some training value is lost because the subjects do not review all of the same tasks. All of these options involve great costs.

The physicality of the landforms and assets used in planning training in live simulation also limit their use versus the virtual and constructive arenas. If an asset is planned to be used in a live simulation exercise, it must first exist and be moved to the proper location. Once in place, the unit, or resource, will consume other resources in the accomplishment of its tasks. These tasks will usually have impact on the other units in the area and the landform. This impact means that if the asset is to be used again some effort must be made to return it to its initial conditions and move it or the elements around it for its next use. This requires a great deal of effort in planning to accomplish efficiently.

Virtual and constructive simulations do not have this physical impact problem. Resources and units can be created exclusively for the exercise. Fuel for live exercises must be purchased and distributed to the forces for consumption. In virtual exercises the resource can simply be incremented from a controller's workstation. Unit strengths can also be treated this way. In virtual or constructive simulation an enemy force can be automated or semi automated (SAF). This allows the trainers to conserve resources operating the enemy as opposed to live training where Opposing Forces (OPFOR) need all the same resources as the primary training audience.

In virtual and constructive simulation the transition to the next training task is almost effortless. Virtual forces can be relocated to any place in the computer based battlefield in a moment of time with the effort of a skilled computer operator. The transition also does not involve returning the training area to its original condition. The

units do not have to fill in dug in positions, retrieve sensors and other equipment, and reduce obstacles that were deployed during the exercise.

Thus, the factors that make planning live training easier to conceptualize become constraints in that expensive resources, detailed planning, and large amounts of coordination have to be accomplished in order to provide worthwhile training to any unit larger than squad size.

Virtual and Constructive Training

Planning virtual and constructive training is more difficult than planning live training because of the lack of a physical interface. The inability to see and understand the training area reduces the planner's ability to predict the direct actions of the units. This inability to conceptualize the flow of actions and predict the actions of units at the lowest level alters the training at the higher levels.

A trainer working with virtual and constructive simulation also has many more choices than trainers who use live simulation. The large costs associated with the movement and operation of people and equipment over great distances limits most live training to areas close to the element's permanent location. Virtual and constructive training are not similarly limited. Once the virtual and constructive simulator training sites are established (physically established training center, not digitized terrain), units can use these facilities to train in any location available to the database (as represented in

the virtual or constructive world). The training planner can conduct training under almost any conditions at any location and move from one position to the other with essentially no significant impact. This escalation in the number of training options without a significant change in planning time leads to a less thoughtful consideration of each option. As the number of options (scenarios) increases while the planning time remains constant, the consideration time per option decreases. This is coupled with the fact the virtual or constructive simulation planner may have to rely solely on a computer monitor or graphic map for inspecting the terrain. In this manner, the selection is complicated by a lack of resources (time) and reduced information.

Shortcomings of Existing Planning Tools

The Army has also experienced dissatisfaction with the current tools designed to support the use of virtual and constructive simulation training. Units from the 101st Airborne Division (Air Assault) at Fort Campbell, Kentucky to the 24th Infantry Division (Mechanized) at Fort Stewart Georgia, have expressed dissatisfaction with the tools used to plan simulation based training (Barrett, Telephone Interview, 1996, Rossi, Telephone Interview, 1996). One of the key shortcomings identified by the units in the field as well as Dr. Larocque, the Director of the National Simulations Center at Fort Leavenworth, is the lack of METT-T responsiveness within the planning tools.

This dissatisfaction with the planning tools occurs at the same time the U.S. Army has undergone increased reliance on simulation based training and the establishment of extensive simulation libraries.

Standard Army Training System

The Standard Army Training System (SATS) is an automated training management tool the Army created to ease the burden of units in all types of training. The current version, 4.1, is being fielded to many units now. SATS-TREDS (Standard Army Training System-Training Exercise Development System) is a prototype training exercise planning tool being developed for the Combined Arms Tactical Trainer (PM-CATT) at STRICOM.

SATS-TREDS was designed to mimic the mental models of a Subject Matter Expert's (SME) conceptual planning development process (Stone, The Use of Computer-based Planning to Enhance the Effectiveness and Efficiency of Simulation-based Team Training, 1996). The planning tool was developed using interviews, conference data, rapid prototyping, commercial off the shelf software and the Cognitive Analysis Tool© (Stone, 1996).

The system's current capabilities include scheduling, monitoring unit proficiency, exercise products, training assessment tools, a scenario library, and mission and task selection. Though SATS-TREDS is designed to be used by a company, battalion and brigade staff, its exercise products support all levels of training from brigade to platoon.

Simulation scenario libraries, under the current version of SATS-TREDS, are searched using tasks lists. The planner creates a task list (This addresses the unit's

mission) by entering all of the tasks he wishes to train. All of the scenarios are then compared to this task list and the scenarios with the highest number of matches are reported to the planner as the most suitable. This gross search requires the user to manually examine each returned scenario for other factors that will affect his selection decision. For example, a user must analyze each scenario in terms of METT-T factors which include the training unit's mission (Defense in sector vs. Deliberate attack), the expected enemy (Motorized rifle regiment vs. Tank battalion), the terrain in the area (jungle vs. desert), friendly troops that are available (a pure infantry battalion vs. and armor task force) and time available as well as combat power ratios and the training units level of proficiency. This refinement process must be analyzed for the possible formal adoption and automation.

As the official scenario library is used, commanders will modify the sanctioned scenarios to make them more useful to their units. This process will quickly expand the number of scenarios available to the units and make their selection procedure more complex. It becomes more difficult to differentiate between similar scenarios as they branch from a root official scenario. Therefore, the refinement of the scenario selection procedure by the inclusion of significant METT-T factors will improve the unit training planning process. No work has been done on selecting training scenarios based on METT-T or other factors instead of task lists. The first step in understanding how METT-T might impact on scenario selection begins with gathering information about the

possible relationships between the two. Given the diversity of U.S. Army-wide needs, a methodology must be identified by which to determine:

1. What method of knowledge acquisition is most suitable for collecting information from a widely- dispersed non-homogeneous population?
2. What means of analysis are the most appropriate for differentiating levels of significance between the selection factors?
3. How can this information be applied to the selection of simulation-based training scenarios?

Part of this research process will be the quantification or classification of the existing scenarios and user preferences. Principles of classification must be harnessed to ensure that the classification system has the granularity to support a discriminating search process.

Task Performance Support Codes

Task Performance Support (TPS) Codes were developed by Sherikon in support of the automated SATS-TREDS tool as part of the Close Combat Tactical Trainer program. Sherikon developed this methodology to quantify the degree with which a simulation supports training a particular task (Sherikon, Task Performance Support (TPS) Codes. 1995). The TPS Code methodology adheres to the following principles:

1. There must be a single methodology which can be applied to all collective training simulations.

2. The resulting codes must have sufficient granularity to provide reasonable assurance of distinguishing between simulation environments at the Mission Training Plan level.
3. The methodology must be efficient, unambiguous, repeatable and automated.
4. The methodology must be documented to facilitate reuse as new tasks are added or old ones are modified.
5. SME assessments must be retained in a automated format for traceability and consistency analysis. (Sherikon, 1995, pg. 10)

The TPS Code principles could also be applied to the problem of quantifying the characteristics of each simulation scenario in terms of the scenario's association with the METT-T factors.

Methodological Vision

An intuitive approach to quantifying the characteristics of each simulation scenario will:

1. build on successful previous simulation scenario selection efforts;
2. determine user simulation training scenario selection criteria;
3. quantify selection criteria so that it can be systematically applied to training scenarios and the training scenario selection process (weights);

4. apply the weights in a manner that supports meaningful discrimination of alternatives;
5. ensure the process supports automation to reduce the training planner workload.

While these qualities may appear instinctive, it also constitutes a vision whereby the characteristics of simulation scenario's are quantified to better enable the user to select the optimal scenario. The most important parts of this vision are the ability to assign weights to the selection factors and application of the weights in a manner that supports discriminating decision making.

The value of determining the weights or relative degrees of importance of the simulation training scenario selection factors is that the weights allow the selection process to become multi dimensional. The tool can mimic the planners mental process of considering many different factors and assigning them differing levels of importance to the decision at hand.

The application method is important because it prepares a sound decision making process for automation. Once the process can be automated it can reduce the workload and increase the accuracy of the user.

Summary

Military training has focused on live simulation training since its inception. This has lead to excellent tools and methods for planning live training. Simulation based

training has lagged behind this effort because of the relative youth of the technologies that have made computer based training possible. Several categories of research have to be examined in order to contribute to the vision of simulation training planning and scenario selection. Areas of training, expert systems, METT-T, information elicitation, statistical analysis, and simulations have to be examined next. These efforts will improve the development of the envisioned methodology.

CHAPTER 3 THE PREFERENCE-CHARACTERISTIC CODE METHODOLOGY

Building on Previous Efforts

Understanding how METT-T and other factors might effect selection of a simulation training scenario begins with a mapping of the steps taken by a training planner. These steps could be transformed into a methodology which could be subsequently automated. This research attempts to propose and demonstrate the use of one such approach referred to herein as the Preference-Characteristic Code (PCC) methodology. The PCC methodology utilizes SATS-TREDS and many sources.

The U.S. Army's current Training Management and Battle Focused Training Doctrine as well as the continuing efforts in training development being done by the Army Research Institute (ARI) support the analysis tools used to plan live training. The CCTT Program and other simulation based training programs provide insight into the future needs of the commanders. The SATS-TREDS planning tools is the most basic launching point a new improved technique that may be applicable to planning simulation-based training in units..

SATS-TREDS provides the first cut of simulation training scenario selection. PCC is designed to refine the search conducted by SATS-TREDS. The PCC methodology may be used as an initial search as well.

Simulation Training Scenario Selection Criteria

Simulation training scenario selection criteria needs to based on U.S. Army doctrine and training practices. Battlefield Operating Systems (BOS), Principles of Training, and METT-T are the most promising expressions of U.S. Doctrine and training practices for selection criteria use.

The Battlefield Operating Systems are the major functions a commander uses to ensure he accomplishes his mission (Training Management, 1991). Intelligence, Maneuver, Fire Power, Mobility/Counter Mobility/Survivability, Air Defense, Combat Service Support, and Command and Control are all of the systems present on the battlefield. These systems may not be appropriate or germane to all training situations because of unit "pure" training that may be done in simulations such as the Mobile Target Simulator (MTS) for Air Defense units or the Advanced Target Gunnery System (AGTS) for Armor.. The fact that they cannot be consistently applied to all cases could lead to a loss of granularity in the selection process.

The nine Principles of Training act as imperatives dictating the conduct of training (Training Management, 1991). The concepts of training as combined arms, training as you fight, training to maintain, training using multi-echelon techniques are easy to quantify and identify. However using appropriate doctrine, training to challenge, and using performance-oriented training would be hard to quantify. The inability to

apply all of the criteria to reasonable degree to all of the scenarios and preferences eliminated this as an option.

Not only was METT-T the recommended medium from the units in the field, it seems that the elements of METT-T are most applicable to the problem at hand. Mission, Enemy, Terrain, Troops, and Time can be defined, quantified and applied to the scenarios and planner preferences. METT-T is applied to course of action analysis and other tactical decisions. Though METT-T can be broadly applied both to the scenario's and the users preferences, it should be bolstered with considerations affecting unit assessment, previous use of a scenario, difficulty, and available simulators.

METT-T Application

The five METT-T factors can easily be broken down into more precise sub-categories that are easily recognizable to military trainers. Table 3 breaks the five factors into sub-categories and adds some general factors of interest.

TABLE 3 METT-T CATEGORIES AND GENERAL SELECTION FACTORS

METT-T Category	Selection Factor
Mission	Task Combat Power Ratio
Enemy	Enemy Composition Enemy Task Organization Enemy Equipment Enemy Training Level Enemy Mission
Time	Exercise Preparation Time Mission Planning Time
Terrain	Terrain Weather Light Data
Troops	Friendly Composition Friendly Equipment Adjacent Unit Supported Observation Devices
General	Previous Use of a Scenario Difficulty Simulator Assessment

The selection factors may be broken down into meaningful divisions. These divisions allow the scenarios and the users preferences to be coded. Coding supports automation of the selection processes.

Quantification of Selection Criteria and The Manner of Application

The selection factors from Table 4 are broken down into categories based on the U.S. Army's training doctrine and methods. These selection factors can be used to

describe user preferences sought in a scenario that maybe used for basis of training. Similarly, the available simulation training scenarios might be evaluated and classified to indicate whether or not they offer the characteristics sought by the trainer.

The list of user preferences may be grouped to form a matrix of preferences referred to as the User Preference matrix (UPM) or the User Preference Code (UPC). The list of scenario characteristics can be grouped to form the Scenario Characteristic matrix (SCM) or Scenario Characteristic Code (SCC). Given the importance of the factors in Table 4 both the UPC and SCC structured around these factors as discussed below.

Mission

Task:

The U.S. Army breaks all operations down into a series of collective and individual tasks (Training Management, 1991) This type of decomposition supports the analysis of large complex missions in terms of the functions or tasks the subordinate elements must accomplish.

This type of crosswalk relationship carries over into the Army Training Evaluation Plan (ARTEP) Mission Training Plan (MTP) manuals. MTP manuals contain the standards of performance of these tasks along with the breakdown of who or which element must perform each sub-task.

When considering how military units might go about applying simulator training systems to training a unit in a particular task, the planner first begins with identifying the

tasks to be trained. This task list is the basis of the SATS-TREDS selection process. For the purpose of this research one task can be determined the most important task to be trained. This selection can be codified in the Task matrix, $[t_{i,j}]$. The Task matrix is later intersected with a Scenario Task matrix $[T_{ij}]$ which contains all of the tasks supported by the training scenario. If the intersection of the matrixes results in the null set, the scenario in question does not support training the task to be trained.

This relationship between the tasks to be trained and the tasks supported by the scenario yields the first element of the User Preference Code (UPC). If the scenario does not support the required task, $U_{1,1}= 1$. Otherwise, $U_{1,1} = 0$.

If there is no particular task that must be trained $U_{11}= 0$.

Combat Power Ratio:

Combat Power Ratio (CPR) refers to the aggregated strength levels of the opposing forces in the simulation training scenario expressed as a ratio of friendly forces to enemy forces. There exists normally acceptable ratios for certain types of operations. An example of this is that U.S. Army forces prefer to attack if the CPR is equal to or greater than 3:1. Ratios above this (3:1) favor the attacker, while ratios below this favor the defender.

The user's selection of CPR above or below the doctrinal level determines the value of the UPC element $U_{1,2}$. Similarly the ratio that exists in the scenario determines

the Scenario Characteristic Code (SCC) element $S_{1,2}$. The actual values for the element are found in Table 9 in Appendix B.

Enemy

Enemy Composition:

It is impossible to create a finite set that covers all aspects of enemy composition. To streamline this process the U.S. Army has developed various templates that are based on the enemy's characteristics. Though the Soviet Union no longer exists, its previous activities within its sphere of influence affected the equipment and doctrinal structure of many potential adversaries throughout the world (Soviet Army Equipment, Organization, and Operations, 1991). For this reason its former configurations and tactical dispositions make reliable starting -points for enemy classifications.

The User's Preference Code ($U_{1,3}$) for enemy composition as well as the Scenario Characteristic Code ($S_{1,3}$) are based on theses models. The coded values used for these elements are drawn from Table 10 in Appendix B. In the table the expected major enemy organizations are listed along with a coded value to represent them.

Enemy Task Organization:

The enemy's task organization is dependent to a large degree upon the role it plays within the enemy's larger plan. It is convenient to look at this aspect in terms of where the enemy unit exists in the enemy's maneuver structure (Soviet Army Equipment,

Organization, and Operations, 1991). For the purpose of templating the enemy this method is very useful.

The UPC ($U_{1,4}$) and the SCC ($S_{1,4}$) elements are determined from Table 11 in Appendix B. In the table the possible elements of the enemy organizations are listed along with a coded value to represent them.

Enemy Equipment:

The enemy's equipment can be generally categorized in terms of their most lethal maneuver systems. The most lethal systems available to most of our potential enemies are the T-80 main battle tank, the BMP-3 infantry fighting vehicle and the Holkum attack helicopter (Soviet Army Equipment, Organization, and Operations, 1991). More common, and less capable, systems in these categories are the T-72 series tanks, the BMP-2 infantry fighting vehicle, and the Hind series attack helicopter. If the enemy force has certain combinations of these systems, assumptions can be made about the other indirect fire and combat systems he possesses.

Knowing that the enemy posses certain weapon systems indicates some of their likely courses of actions, capabilities, and tactics.

The UPC ($U_{1,5}$) and the SCC ($S_{1,5}$) elements are determined from Table 12 in Appendix B. In the table the major weapon system classifications are listed along with a coded value to represent them.

Enemy Training Level:

Most training simulations use stochastic methods to determine target hits, kills and detection (Combat Simulation Laboratory, undated). Increasing or decreasing these levels may effect the effectiveness of the enemy elements which could be taken as improved or depressed levels of training. These characteristics can be important when a military planner prepares for battle or training.

The UPC ($U_{1,6}$) and the SCC ($S_{1,6}$) elements are determined from Table 13 in Appendix B. In the table the levels of probabilities of hit, kill and detection are listed along with a coded value to represent them.

Enemy Mission:

The enemy's mission has a significant impact on the activities he may engage in during a training session. The former Soviet Union and their client states only executed six (6) types of missions (Soviet Army Equipment, Organization, and Operations, 1991).

The UPC ($U_{1,7}$) and the SCC ($S_{1,7}$) elements are determined from Table 14 in Appendix B. In the table the possible enemy missions are listed along with a coded value to represent them.

Time

Exercise Preparation Time:

The amount of time and effort involved in the preparation of a training exercise can effect its selection. If an organization has a small amount of time to prepare for training (a National Guard or Reserve Unit) they may prefer to select simulation training scenarios that allow minimal unit planning prior to training execution. Scenarios with minimal preparation time may include very detailed graphics, training schedules, coordination check lists.

The UPC ($U_{1,8}$) and the SCC ($S_{1,8}$) elements are determined from Table 15 in Appendix B. In the table the levels of exercise preparation time are listed along with coded values to represent them.

Mission Planning Time:

Mission planning time refers to the amount of tactical planning and operations order development the unit must do. Units that are incomplete staffs or have the staff dedicated to other missions may wish to execute supplied orders. Similarly, the units staff may not be prepared to execute the mission planning process in the available time

The UPC ($U_{1,9}$) and the SCC ($S_{1,9}$) elements are determined from Table 16 in Appendix B. In the table the levels of mission planning required are listed along with coded values to represent them.

Terrain:

The United State Army must be prepared to execute its missions anywhere in the world. This drives the requirement that the U.S. Army train on all different types of terrain, weather, and light conditions. For this reason the planner needs the ability to distinguish between the various land forms the unit could train on.

The UPC ($U_{1,,10}$) and the SCC ($S_{1,10}$) elements are determined from Table 17 in Appendix B. In the table the major land forms are listed along with coded values to represent them.

Weather:

Weather affects numerous aspects of tactical operations. Trafficability, equipment performance, tactics and procedures are effected by weather. Training planners may want to gauge their units ability to adapt to these different conditions.

The UPC ($U_{1,11}$) and the SCC ($S_{1,11}$) elements are determined from Table 18 in Appendix B. In the table the weather conditions are listed along with coded values to represent them.

Light Data:

Light data affects numerous aspects of tactical operations. Equipment performance, tactics and procedures are effected by light data. Training planners may want to gauge their units ability to adapt to these different conditions.

The UPC ($U_{1,12}$) and the SCC ($S_{1,12}$) elements are determined from Table 19 in Appendix B. In the table the light conditions are listed along with coded values to represent them.

Troops

Friendly Composition:

Though the system will take the unit data that is in use as a default, the Friendly Unit Composition can be altered. This allows the commander to plan training for the units one level down. This could happen in preparation for an evaluated training exercise or assigning directed training.

The UPC ($U_{1,13}$) and the SCC ($S_{1,13}$) elements are determined from Table 20 in Appendix B. In the table the units are listed along with coded values to represent them (Organization of the Army in the Field, 1991).

Friendly Equipment:

The system default would be set for the unit's Table of Organization and Equipment (TO&E). However, units periodically deploy and unitize pre-positioned equipment. The propositioned equipment may be different from the equipment that the unit has at its home station. The ability to choose different equipment could affect the scenario selection.

The UPC ($U_{1,14}$) and the SCC ($S_{1,14}$) elements are determined from Table 21 in Appendix B. In the table friendly equipment categorize are listed along with coded values to represent them.

Adjacent Unit:

The U.S. Army has become increasingly involved in multi-national operations such as Somalia, Haiti, Macedonian, and Bosnia. When training for such missions it may become important to be knowledgeable about the allies' equipment, tactics , and capabilities.

The UPC ($U_{1,15}$) and the SCC ($S_{1,15}$) elements are determined from Table 22 in Appendix B. In the table possible allies are listed along with coded values to represent them.

Supported Observation Devices:

All simulations do not have the same capabilities to support or model different battlefield sensors (Combat Simulation Laboratory, undated). This demands that the planner have the ability to select simulations based on their capabilities.

The UPC ($U_{1,16}$) and the SCC ($S_{1,16}$) elements are determined from Table 23 in Appendix B. In the table sensors are listed along with coded values to represent them.

General Category

Previous Use of a Scenario:

The value of training can be degraded if the training audience constantly uses the same situations to learn (Anderson, 1993). However, repeating an exercise that was incorrectly performed can boost learning. Depending on the number of attempts to complete a single scenario the planner may wish to exclude or repeat a scenario.

The user's desired Previous Use of a Scenario determines the relationship between the Previous Use matrix,$[P_{i,j}]$, and the scenario number. If the user wants to reuse a scenario, the Preference-Characteristic Technique (PCT) examines the intersection of the set of used scenarios and the current scenario. If the intersection is the null set, $U_{1,17} = 1$, otherwise $U_{1,17} = 0$.

If the user does not want to reuse a scenario and the intersection is the null set then $U_{1,17} = 0$, otherwise $U_{1,17} = 1$.

Level of Difficulty:

In an effort to stress the training unit or to utilize a Crawl-Walk-Run training methodology it is needed to know the degree of difficulty associated with a simulation training scenario. Though the issue of how to objectively quantify the degree of difficulty is unresolved, there is a benefit to be gained throughout the application of the information.

The UPC ($U_{1,18}$) and the SCC ($S_{1,18}$) elements are determined from Table 24 in Appendix B. In the table levels of difficulty are listed along with coded values to represent them.

Simulator:

There may be constraints on the training plan that limit the user to a specific type of training simulator. This could be a resource constraint or an issue of the capabilities of a simulator to support a particular exercise. This generates the need for this element.

The UPC ($U_{1,19}$) and the SCC ($S_{1,19}$) elements are determined from Table 25 in Appendix B. In the table simulator systems are listed along with coded values to represent them.

Assessment:

U.S. Army training strategies focus on sustaining proficiency in tasks that are executed well and improving performance in tasks that are not executed well. Since all

training is evaluated and unit performance on critical tasks is formally evaluated quarterly, it is possible/desirable to give preference to simulation training scenarios that train tasks that have been identified during assessment as not being well executed (Training Management, 1991).

The user's desired use of the unit assessment data produces the following values of $U_{1,20}$:

> If the user wants to consider Unit Assessment data: The tool examines the intersection of the set of the Scenario Task Matrix, $[T_{i,j}]$, and the Untrained Matrix, $[F_{i,j}]$. The Untrained Task matrix is a set of tasks that the unit has identified through the training management process that they do not execute well. If the intersection is the null set, $U_{1,20} = 1$, otherwise $U_{1,20} = 0$.
>
> If the user does not want to consider unit assessment data , then $U_{1,20} = 0$.

The elements of the Scenario Characteristic Code matrix, $[S_{i,j}]$, correspond to those of the User Preference Code matrix, $[U_{i,j}]$. The elements that relate directly to the past actions of the training unit in the UPC matrix, $U_{1,1}$, $U_{1,17}$, $U_{1,20}$, all equal zero (0) in the SCC matrix, $S_{1,1}$, $S_{1,17}$, $S_{1,20}$.

Preference-Characteristic Matrix Technique

The Scenario Characteristic Code (SCC) then is a 1 x 20 matrix, $[S_{1,j}]$, whose elements, $S_{1,j}$, are coded qualities of the scenario in terms of the METT-T factors of mission, enemy, time, terrain, and troops.

The SCC elements are first organized by grouping all of the factors according to their METT-T associations as shown in Table 3.

The scenarios are then analyzed according to these factors by the standards and categories established in Tables 9 through 25. The elements characteristics are compared to the properties on the tables and categorized. The various categories on the charts are designed to be exhaustive. If in evaluating a scenario or preference it is not possible to place it into a category then an additional category must be added.

Each selection factor is discussed above along with an accompanying table (Table 9 through 25) that lists the possible values that enter the matrices based on the scenario's characteristics or user's preferences.

The SCC is subtracted from the User Preference Code (UPC), which is also a 1 x 20 matrix, $[U_{1,j}]$. The elements of the $[S_{i,j}]$ are determined by examining the scenario, while the $[U_{i,j}]$ is determined by the user.

The Scenario Task matrix, $[T_{i,j}]$, is a listing of all of the training tasks associated with a scenario.

The Task matrix, $[t_{i,j}]$, is a matrix containing the most important training task as determined by the user.

The Previous Use matrix, $[P_{i,j}]$, consists of a list of all of the scenarios used by the unit.

The Untrained Matrix, $[F_{i,j}]$, consists of a list of all of the METL tasks that the unit has incorrectly performed or for which the unit has failed to perform one or more critical subtasks. This classification of Untrained follows Army guidance (Combined Arms and Service Staff School, 1991).

The Calculation of the Weighted Result

Once the UPC and SCC matrices are constructed, the SCC matrix is subtracted from the UPC matrix. The resulting Difference matrix, $[D_{1,j}]$, is examined for the value of the elements, $D_{1,j}$.

If $D_{i,j}$ is equal to 0, then $U_{1,j} = 1$.

If $D_{i,j}$ is equal to (-1) $S_{i,j}$, then $U_{1,j} = 1$.

Otherwise, $U_{1,j} = 0$.

The assignment of the value 1 to $U_{1,j}$ if $D_{i,j}$ is equal to 0 or if $D_{i,j}$ is equal to (-1) $S_{i,j}$, is made so that a scenario receives a benefit if the matrix element of UPC is the same as the element of the SCC or if the user expressed no preference in that category. For example, if the user wants a scenario that has U.S. Marines as the adjacent unit and the user has no preference for supported imaging devices, the UPC would have a value of 9 for $[U_{1,15}]$ and a value of 0 for $[U_{1,16}]$. If one of the compared simulation training scenarios had values for those elements of $[U_{1,15}] = 10$ and $[U_{1,16}] = 2$ $(-2 = -S_{i,j})$ the

values for the Difference matrix would be $[D_{1,15}] = 0$ and $[D_{1,16}] = -2$. The adjacent unit characteristic should lead to positive consideration because it is the desired characteristic and the observation devices should have a positive impact because the user had no preference. The scenario receives no benefit if the scenario characteristic is different from the user's expressed preference.

The revised UPC matrix could be multiplied by a set of weights, the Weight matrix $[W_{i,1}]$. The Weight matrix accounts for the differing levels of importance the selection factors have.

This results in Rank matrix $[R_{1,1}]$. $$\left[R_{1,1}\right] = \left[u_{1,1}, u_{1,2} \ldots u_{1,20}\right] * \begin{bmatrix} w_{1,1} \\ w_{2,1} \\ \cdot \\ \cdot \\ w_{20,1} \end{bmatrix} = \left[\sum_{k=1}^{20} u_{1,k} w_{k,1}\right]$$

(equation 1)

The Rank matrix is a single number whose value is proportional to the scenario's agreement with the user's preferences. A Rank matrix can be calculated for each scenario that SATS-TREDS has returned as matching a number of tasks. The Rank matrix now permits the automated differentiation of simulation training scenarios based on user METT-T preferences. An example illustrating the use of the Rank matrix appears in Chapter 6-Data Analysis.

The success of the methodology hinges on the ability to define a discriminating Weight matrix. The Weight matrix must be developed through the elicitation of knowledge from the expected using population or a sample of that population. The Weight matrix will allow the appropriate level of significance to be applied to each dimension (selection factor).

Summary

It is possible to define a series of matrices that describe the tool user and his desires, training audience, the units training activities and the available simulation training scenarios. These matrices can then be manipulated along with an objective Weight matrix to determine the best simulation training scenario to meet the users preferences. The key to the applicability of the matrix technique is the evaluation of the Weights matrix.

CHAPTER 4 A TECHNIQUE FOR EVALUATING THE WEIGHTS MATRIX

This research effort produces weights for METT-T factors. Those weights form the basis through which Scenario Characteristic Codes (SCC's) can be used by an automated tool to distinguish between simulation training scenarios that support equal numbers of training tasks. This is different from SATS-TREDS which currently sorts solely on the number of tasks supported by the scenario.

Theoretical Approach to Gathering Information Needed to Refine Scenario Selection

It would be possible to gather the information needed to augment the current scenario selection system through many means. The information concerning the use of METT-T factors in selecting a training scenario could be acquired using a subject matter expert, a Delphi group technique, or a survey. After the information is gathered a development process has to be selected in order to produce an exercise development tool.

The Use of Subject Matter Experts

The use of a subject matter expert (SME), with a great deal of experience with training in units, would yield valuable information in a very timely manner. A single person's input could be easily quantified and developed into a useful tool. A useful three phase method for extracting this information is commonly used; unstructured interviews, recording of the task, and structured interviews (Williams, 1995). The first phase is to conduct unstructured interviews focusing on the general task being analyzed. This initial interview is limited by the extent of domain knowledge held by the knowledge engineer (Kotnour, Design, Development, and Testing of an Automated Knowledge Acquisition Tool to Aid Problem Solving, Decision Making, and Planning, 1992). This is followed by recording (using video tape or other devices) the actions of the expert while engaged in the task. The recording is then analyzed by the SME along with the researcher. This analysis consists of structured interviews in which the SME describes the process portrayed in the recording (Welbank, An Overview of Knowledge Acquisition Methods, 1990).

Though great insight can be gained through this technique, a single SME's opinion may not prove to be representative of the entire population. The application of the information is going to vary over the entire Army at a tactical level of application. Though a person could easily become an expert in a single aspect of the battlefield and training, at this level the unique requirements of the different military specialties and

their associated idiosyncrasies would not support the formulation of a broadly utilized planning tool.

Group Techniques

The Delphi or Nominal Group techniques may also suffer from a lack of a wide base of knowledge. The Nominal Group Technique (NGT) utilizes a group of five to nine experts in a structured environment. The participants are prompted to compose a list of issues concerning a given problem. After each member of the group shares the factors they listed, the group discusses each item to produce a common definition. The experts then rank order the choices, and the facilitator tabulates the data and produces a ranked list. After group discussion of the preliminary ranked list a final vote is taken and a final rank order is produced (Delbecq, 1975).

Like the NGT, the Delphi process is used for aggregating group judgment and for distilling information on highly complex problems (Adler and Ziglio, 1996). The Delphi technique differs from the NGT in that the participants do not interact or discuss the issues that are presented. The facilitator simply gives each participant an issue statement in the form of a survey. The survey is then collected and the facilitator lists the ideas of the experts and returns this new list to the individuals for ranking. A ranked list is then produced as in the NGT (Delbecq, 1975). The lack of discussion of the issue between the experts makes this technique less desirable. Strengths of the Delphi method are that

it can be used in settings where the participants cannot be brought together, it is impossible for a forceful advocate of a view to dominate discussion, and its structure reduces the possibility of "group think" (Adler and Ziglio, 1996).

Though the collection of experts would broaden the applicability of the resulting tool, the results are still constrained to a smaller population of the whole. The values generated by the exercise would also be "averaged" over the whole population. This means that the method would be less able to determine the needs of smaller segments of the total population.

The Delphi and Nominal Group Techniques are also time and resources intensive. The experts must be committed to the solution of the problem, willing to dedicate large blocks of time, and must be brought together at one location. This manipulation of the participants drives up the cost of the process.

Surveys

The use of a survey would allow for the elicitation of information from a much larger and more diverse population. This much larger population would support further analysis into sub groups characteristics. The cost associated with the data collection would also be much less than the other methods. However, the collection technique would suffer in timeliness.

Survey and Question Design

Three major requirements of a survey is that it is unambiguous, easily understood, and returned. There are many methods that can be used for implementing the survey depending on its use and the resources associated with the project. The main types of surveys are random sampling surveys and directed surveys (Lehtonen and Pahkinen, Practical Methods for Design and Analysis of Complex Surveys, 1995). These are implemented using mailed surveys, telephone interviews, and personal interviews. There are advantages associated with each type of survey and the associated implementation methods.

Random sampling surveys are used for definitive results over an entire population or survey frame. They are expensive in administering because of the low response rate and high number of returns needed to establish validity. Directed surveys are used in pilot studies (Fink, 1995).

Table 4 compares the various survey implementation strategies.

TABLE 4 SURVEY TECHNIQUE COMPARISONS

Aspect of Survey	Mailed Survey	Telephone interview	Face to face interview	Web Page Surveys
Administrative				
Cost	Low	Low/Medium	High	Medium/High
Length of data collection period	Long	Short	Medium/Long	Long
Geographic distribution	Wide	May be wide	Clustered	Very Wide
Survey Issues				
Length of survey	Short (4-12 pages)	Medium/Long 1/4-3/4 hour	Long 1/2-1 hour	Short (4-12 pages)
Complexity of questions	Simple to moderate	May be complex	May be complex	Simple to moderate
Sensitive topics	Good	Fair/good	Fair	Good
Non threatening questions	Good	Good	Good	Good
Data Quality Issues				
Sampling frame bias	Low	Low	Low	Low
Response rate	45%-65%	60%-90%	65%-95%	45%-65%
Response bias	Medium*	Low	Low	Medium*
Control of response situation	Poor	Fair	Good	Poor
Quality of recorded response	Fair/good	Very good	Very good	Fair/good

*Czaja indicates that response bias is lower in more educated respondents. (Czaja, 1996)

It takes approximately 400 responses from the population to achieve a 0.05 level of confidence that the results of the survey accurately portray the beliefs of the population (Czaja, Designing Surveys, 1996).

The number of valid responses needed to determine a valid output from a survey is determined by the size of the total population, the probability level, the expected variance, and the confidence interval that is acceptable within the study.

$$n = \frac{t^2 (p^* q)}{d^2} = \frac{Probability\ level\ ^* variance}{confidence\ interval}$$

Where:

(equation 2)

n = The sample size or the number of completed interviews with eligible elements.
t^2 = The squared value of the standard deviation score that refers to the area under a normal distribution of values.
p = The percentage category for which we are computing the sample size.
q = 1-p.
d = The value of one half of the precision interval around the sample estimate.

This formula is applicable for surveys of less than 5% of the total population. If more than 5% of the total population is surveyed, then a finite population factor is applied (Cochran, Sampling Techniques, 1977).

$$n = \left(1 - \frac{n}{N}\right) \frac{t^2 (p * q)}{d^2}$$

(equation 3)

Where:
N = The size of the eligible population
All other variables are the same as in equation 1.

Calculating the required sample size for a random sample of the eligible population is made using the first equation without the finite population factor. Assuming a desired 95% probability level, a 0.05 confidence interval, and a percentage category for which we are computing a sample size of 50% yields a sample size of 384. The initial percentage category is assumed to be 50% because there is a lack of information about the population. The calculations following the pilot survey will update this value. At an expected response rate of 45% the number of unsolicited mailings becomes quite large (854).

The directed survey is much less costly to use and results in a much higher response rate. The higher response rate eliminates some biases but the method is best used when doing pilot surveys (Fink, 1995).

Ronald Czaja and Johnny Blair (1996) indicate that the survey should not exceed 10 pages in length, should appear uncluttered, should provide easily identifiable answer spaces. They continue to establish that the survey should have an introduction that explains the purpose of the survey and should engender the subject to complete the survey. A respondent section that allows the information to be collected on the subject of

the survey. This is the area where demographic information (independent variables) is gathered. The substantive questions follow. Theses questions are designed to measure the beliefs of the subjects (dependent variables) (Fink, The Survey Handbook, 1995). The survey was constructed so as to have construct validity, so as to establish that people with different characteristics have different beliefs (Fink, 1995).

Summary

The careful construction of a survey directed at a representative population can garner valuable information. Effort must be made to ensure that the solicited responses address the issues queried. If this is the case, the data can be screened in terms of frequency and means to produce usable information--The Weight Matrix. The information within the applicable domain (user preferences and training scenarios) can then be manipulated to determine the relative ranks of the scenarios. It is important to determine if the analysis techniques and instrument are valid. Table 5 summarizes the efforts in the literature and their applications. The works and authors are compared to their area of primary focus.

TABLE 5 LITERATURE REVIEW

Work	Author	Training	Expert Systems	METT-T	Survey & Information	Analysis	Simulations
Gazing into the Oracle	Adler & Ziglio				X		
Rules of the Mind	Anderson	X					
Training Management	ACGSC	X		X			X
How Probable is Probable	Beyth-Marom				X	X	
Sampling Techniques	Cochran				X	X	
Designing Surveys	Czaia				X	X	
Group Techniques for Program Planning	Delbecq				X		
Battle Focused Training.	Dept of the Army	X		X			
Expert Systems Design and Development	Durkin		X			X	
The Survey Kit	Fink				X		
Proceedings of the 1991 Summer Computer Simulation Conference	Gorman	X					X
The Secret of Future Victories	Gorman	X					X
The High Level Architecture	Hollenbach						X
Design, Development and Testing of an Automated Knowledge-acquisition Tool to Aid Problem Solving, Decision Making, and Planning	Kotnour				X		
Advanced Questionnaire Design	Labaw				X		
Practical Methods for Design and Analysis of Complex Surveys	Lehtone, Pahkinen				X	X	
Guide for the Use of Models and Simulations	Mercer, & Roop	X					X
The Value of Simulation for Training	Orlansky	X					X
Systems Acquisition Manager's	Piplani,	X					X
Task Performance Support (TPS) Codes	Sherikon.	X	X				X
The Use of Computer-based Planning to Enhance the Effectiveness and Efficiency of Simulation-based Team Training	Stone	X			X	X	X
Commander's Battle Staff	USARI	X					
An Overview of Knowledge Acquisition Methods	Welbank				X		
Task Analysis	Williams				X		
The PCC Methodology	Bedell	X	X	X	X	X	X

CHAPTER 5 INSTRUMENT CONSTRUCTION AND VALIDATION

Purpose

The U.S. Army currently has many effective tools and methodologies for the planning of live simulation training. Literature research indicates there are difficulties associated with virtual and constructive simulation training planning, where as excellent methodologies exist for planning live simulation training. Further, experts indicate that METT-T and other factors could be used to improve the virtual and constructive simulation training planning. Hence, the purpose of the survey used in this research is to determine what METT-T factors affect the selection of virtual and constructive simulation training scenarios. Associated with this purpose are two sub objectives: 1) Determine if the level of importance of the METT-T factors differs between virtual and constructive simulation environments, and 2) Are there population sub-groups between which there are further differences?

Additional points of interest include determining if a strong correlation between virtual and constructive selection factor responses exists and if a significant correlation exists between selection factors within virtual and constructive environments.

Population

The survey must reach the appropriate population if it is to be useful. It is important to define the frame in order to include the people who can contribute to the area of interest while excluding those who cannot. In order to qualify to take this survey, each respondent must be, or have been, responsible for planning training for large groups of soldiers, understand the Army's current doctrine, and understand the Army's training philosophy. This requirement is established to ensure that the respondents are experienced in planning and conducting collective training and are knowledgeable as to the appropriate tactics, techniques, and conditions appropriate to productive training within their specialty. Explicitly, in order to qualify to respond to the survey the participant must meet one of the following sets of criteria.

- A U.S. Army officer, rank of major or above, who has successfully completed at least 50% of The U.S. Army's Command and General Staff School or its Military Education Level (MEL) IV equivalent.
- A U.S. Army officer, rank of captain or above, who has successfully completed a company level command, and currently works at Tactics or Doctrine Division at one of the Branch schools.
- Any U.S. Army officer that is currently serving or has served as a battalion level or above commander or operations officer of an operational unit in the last five years.

A survey is undertaken in six stages. Once the problem is identified and an objective is established the survey must be designed, pretested, finalized, distributed and collected, and analyzed.

There is no Department of the Army requirement for operations officers to have completed Command and General Staff College. However, division commanders usually set that as a local policy (Mahanken, Telephone Interview, March 1997). It is further designated that operations officers are responsible for ensuring that training is "oriented on the conditions and standards of combat" (Combined Arms and Service Staff School, Staff Skills, Roles and Relationships, 1991).

The independent variables are collected by the demographic portion of the survey. Theses variables are specific characteristics of the subjects. These include the facts about the individual's training history, military specialty, and their training experiences

There are two sets of dependent variables. These are the values each study participant places on the METT-T factors for virtual and constructive environments. These measures of belief are collected so they can be compared to the independent variables to check for correlation. A detailed explanation of the purpose and utility of each question is in Appendix B.

Pretesting the Survey

Preliminary

The original survey was composed of eight demographic and 19 substantive questions preceded by a short introduction describing the purpose of the survey. (See Appendix C.) All of the questions were designed to be concrete close ended questions with ordinal, nominative, or numerical responses. This form of question is designed to eliminate any ambiguity in the meaning of the question and confine the responses to a form that supports later mathematical analysis (Fink, 1996). The numerical responses referred to values such as age and military education level; the nominal responses applied to branch of assignment; and the ordinal responses covered the appropriateness of simulators that the respondent has used in the past.

The substantive portion consisted of 19 questions where the respondent is asked to indicate how greatly each factor would affect their selection of a training scenario (ordinal). The ordinal form used for all of these questions was derived from work done Ruth Beyth-Marom which focused the responses to the survey into a form that eliminates ambiguity and fosters analysis. The categorical and numeric responses support both analysis based on frequency of response and analysis of means and variance.

In this form the survey was shown to three observers to discuss content, appearance, and approach. This preliminary phase of pretesting was completed to ensure that the survey appeared professional and seemed to cover the correct material.

Formal

Formal pretesting of the survey and the individual questions used interview, overview, and sample gathering techniques. Survey pretesting to ensured that the questions allowed the respondent to focus on the issue, that there were no social or professional desirability associated with any possible response, that there was no linkage to authority, that all complex terms were defined, and that the dimensions of interest were measured.

The interview or think-aloud technique consisted of separate interviews with active duty army officers ranked captain through lieutenant colonel (7 in total). The selectees belonged to the same frame as the target population. This technique supports the most accurate evaluation of the survey because respondents are asked to read each portion (question or instruction) and relate the meaning of the portion to the interviewer (Czaja, 1996). During this iterative process each question is refashioned so that the interpretation of the question is matched by its intent. No focus groups were used to examine the questions because their use could obscure problems associated with a minority of the group (Fink, How to Design Surveys, 1995).

An overview method was then used to elicit comments on the survey from academic and active duty military personnel involved in simulations. In the overview process the respondent comments on portions of the survey that may seem ambiguous or

unclear. The instructions accompanying the survey were changed based on the feedback gained in this phase.

The final phase of the pretesting of the survey was the giving of the survey to a group of respondents to generate data to be used to test the data analysis techniques. This was done so the appropriateness of the planned statistical analysis techniques could be tested before the survey was distributed to the target population. This exercise produced essentially undifferentiated data. This was caused because the pretest sample did not have (and was not expected to have) the different characteristics that would have revealed different responses.

The survey's final form is as it appears in Appendix D.

Distribution

The survey was sent to selected active duty and reserve brigade and battalion commanders, operations officers, and other qualified respondents. The emphasis was to elicit responses from those units making the greatest use of simulations. The survey went to service branch schools to be evaluated by their respective Tactics Division and Doctrine Division. All respondents were pre-contacted to insure a high rate of return.

Analysis

The common methods of analyzing survey data include means, medians, modes, ranges, standard deviations, and analysis of variance (ANOVA) (Fink, 1995). In surveys comparing nominal independent variables and Ordinal or numerical dependent variables it is customary to conduct the analysis using an ANOVA technique (Fink, 1995). It is also possible to use regression techniques or frequency analysis.

The analysis conducted on this survey is accomplished using means, an ANOVA technique with multiple comparisons, pair wise comparisons using z or t test statistics, and a Chi Squared test for independence to determine:

1. If for the entire sample the factors have an affect on the selection of the training scenarios.
2. If there are factors that are significant in one simulation environment and not the other.
3. If certain selection factors are more important than other factors in a given environment.
4. If different sample sub-groups select different factors as being significant.

An examination of factor means will determine which factors are significant. Any factor whose value (including the confidence interval) is less than or equal to 30 (has a small chance of affecting the selection on the Beyth-Marom scale) will be discounted as not important.

The Fisher technique, a multiple comparison ANOVA, is used to measure the variation in the dependent variables. The variables' confidence intervals around their means will be compared when the they are grouped around the independent variables such as simulation environment (virtual versus constructive) or branch association. This test uses pooled standard deviations so that it compares each mean to the population as a whole.

The fourth group of tests will be done by examining the means within and between each category. This will be done using a simple comparison of the means using the central limit theorem and the equation:

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - D_o}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

(equation 4)

Where

z = the test statistic
$\bar{x}_1$ = the mean from the first sample
$\bar{x}_2$ = the mean from the second sample
D_0 = the hypothesized difference between the two means
σ_1^2 = the variance of the first sample
σ_2^2 = the variance from the second sample
n_1 = the number of points in the first sample
n_2 = the number of points in the second sample

Because $n \geq 30$ the central limit theorem holds so there is no assumption of normalcy required for this test (Malone, Personal Interview, 1996). This test compares each mean against each other.

The simulation environment test results will be compared to similar tests for independence using Chi Squared techniques. The analysis of expected frequency tables will support the determination of whether frequency is independent of the population group or the environment.

Analysis of Pretest Survey Data

The tabulated data from the 30 pretest surveys appears in Appendix E. The pretest group consisted of ROTC cadets. The survey was administered to the cadets as part of their training and all surveys were returned.

Table 6 contains all of the mean values and lists them in descending order. A simple means analysis of the factors indicates that all of the factors are important to the pretest participants in selecting a simulation training scenario. Since all of the factors appear significant in Table 5 according to the screening criteria there is some question as to the validity of the test. These results could accurately measure the importance of all of the factors or could inaccurately report some or all of the factors as important when they truly were not important. They selection factors were selected because of their perceived importance and so it is determined that this result confirms that all of the factors are important to selecting simulation training scenarios.

TABLE 6 PILOT FACTOR MEANS

Constructive	Mean	Virtual	Mean
Exercise Preparation	63.90	Terrain	75.73
Combat Power Ratio	63.57	Weather	73.03
Enemy Equipment	62.77	Previous Use	70.33
Enemy Task Organization	61.43	Friendly Equipment	69.40
Enemy Composition	61.33	Level Difficulty	68.87
Enemy Mission	56.43	Simulator	66.83
Enemy Training Level	56.30	Unit Assessment	66.77
Task	54.33	Combat Power Ratio	65.43
Previous Use	54.17	Enemy Composition	64.43
Observation Devices	54.04	Mission Planning	62.70
Level Difficulty	53.03	Observation Devices	62.40
Mission Planning	52.77	Enemy Training Level	62.10
Light Data	51.23	Enemy Equipment	62.03
Weather	48.73	Friendly Composition	58.90
Friendly Equipment	47.60	Light Data	57.97
Terrain	47.00	Adjacent Unit	57.47
Adjacent Unit	46.03	Enemy Mission	56.93
Unit Assessment	44.80	Task	53.17
Friendly Composition	43.67	Exercise Preparation	51.80
Simulator	42.47	Enemy Task Organization	51.53

(Computer output is located in Appendix F.)

The next item of interest is to determine if the pretest survey could be used to determine if selection factors could have various levels of importance based on the simulation environment. Based on the 95% confidence intervals (CI) for the factor means using the pooled standard deviation, there are several factors that that have different levels of importance based on their association with virtual or constructive

simulations. For example, the factor 'Terrain' in a virtual context has a 95% chance of being between 80 and 70. Terrain in a constructive context has a 95% chance of being between 57 and 37. Because these two confidence intervals do not over lap then the two factors' values cannot be the same at a 95% confidence level. Further examination yields different levels of importance for factors based on environment for "simulator selection"," friendly equipment"," weather", and "observation devices" (See Appendix F).

Determining the ability of the instrument to measure the different levels of importance of selection factors within a single environment is conducted next. A comparison of the means of Observation Devices (OD) and Combat Power Ratios (CPR) was conducted using the z statistic test in the constructive environment (See Appendix G). This test showed that the mean of the CPR was significantly larger than that of OD. Though no normalcy assumption was made using this test, each sample was found to follow a normal distribution using a chi-squared test (See Appendix G). The survey therefore has sufficient granularity to compare mean values within an environment.

A similar comparison of armor (Appendix H) and infantry (Appendix I) branch officers (Branch was assigned randomly for the pilot data) reveals no statistical difference. All of the factors have overlapping intervals. This result was expected because the branch groups were randomly assigned. Therefore the population groups should not have had distinguishing characteristics.

The factor results were also examined using a chi squared test for independence. These tests were done to because they did not rely on the assumptions associated with parrametric statistics. The survey results were tabulated using the frequency of occurrence of each category (Very Small Chance, Small Chance, Could Effect, High Chance , and Very High Chance). The resulting frequency tables appear in Appendix J.

Table 7 shows the frequency of each response's occurrence for the factor Terrain in each environment. The chi-squared test lends support for the ANOVA technique used above. The level of significance (p) from the chi-squared test for independence indicates that the expected frequencies are different for Terrain depending on the environment. This is in agreement with the results of the ANOVA.

TABLE 7 FREQUENCY COMPARISON BETWEEN CONSTRUCTIVE AND VIRTUAL

FACTOR: TERRAIN

Factor Terrain	**Very Small Chance**	**Small Chance**	**Could Effect**	**High Chance**	**Very High Chance**
Virtual	1	2	1	9	17
Constructive	9	4	11	3	3
p=0.000					

Table 8 contains the results of the chi-squared test for the selection factor Task. The large value of "p" indicates that the value associated "Task" is unaffected by changing environments. This supports the ANOVA findings that "Tasks" level of importance unaffected by the choice of environment (See Appendix F).

TABLE 8 FREQUENCY COMPARISON BETWEEN CONSTRUCTIVE AND VIRTUAL

FACTOR: TASK

Factor Task	**Very Small Chance**	**Small Chance**	**Could Effect**	**High Chance**	**Very High Chance**
Virtual	3	3	12	9	3
Constructive	2	9	9	8	2
p=0.422					

Summary

The result of pre-testing the survey is the determination that the survey and the accompanying analysis techniques are valid. The pre-testing of the survey indicates that it should be able to determine:

1. If for the entire sample the factors have an affect on the selection of the training scenarios.
2. If there are factors that are significant in one simulation environment and not the other.
3. If certain selection factors are more important than other factors in a given environment.
4. If different sample sub-groups select different factors as being significant.
5. The value of the Weight Matrix can be determined

It is now appropriate to apply the instrument to the target population.

CHAPTER 6 DATA ANALYSIS

Responses

Eighty-five surveys were distributed of which 79 surveys were returned for the study. Of these 79, 62 were qualified. 6 surveys were not returned. The non-replies were continually re-contacted concerning the missing surveys. The previously agreeable survey candidates stated they had already returned the survey (not received) and were not interested in duplicating their previous responses (2) or that the survey was no longer a priority for them and they could not participate (4). It was determined that 7 more surveys could not be used because the solicited participant had another member of their unit complete the survey (ranked captain through private first class). Twelve of the respondents felt unqualified to estimate the impact the factors would have on determining training scenario selection in the virtual environment. The final response rate was 93%.

The participants qualifications and backgrounds covered all of the officer branches and ranged in rank from captain (assigned to a branch school and therefore qualified) to promotable colonel.

Tables 26 and 27 summarize the population membership information. In Table 26 the affiliation is by branch, the basic category of assignment. In Table 27 the

population is divided into two groups Ground Maneuver and Combat Support and Combat Service Support.

TABLE 26 NUMBER OF RESPONDENTS BY CATEGORY

Branch or Group	Number of responses
Air Defense	4
Armor	8
Aviation	6
Chemical Corps	1
Corps of Engineers	1
Field Artillery	7
Infantry	16
Military Intelligence	1
Military Police	5
Ordinance	3
Quarter Master	3
Signal Corps	2
Transportation Corps	1
Undeclared	4
Total	62

TABLE 27 GROUND MANEUVER AND CS AND CSS RESPONDENTS

Branch or Group	Number of responses
Ground Maneuver	24
Combat Support and Combat Service Support (CS and CSS)	21
Total	45

The categories "Ground Maneuver" and "CS and CSS" were constructed from the responses. Ground Maneuver consists of the Armor and Infantry data while CS and CSS is made up from the data associated with Air Defense, Chemical Corps, Military Police,

Ordinance, Quarter Master, Signal Corps, and Transportation Corps. The Undeclared category is made up of the respondents who elected not to enter a branch. The complete set of tabulated data can be found in Appendix K. In the appendix the data is presented as the entire population and broken down into each group.

Tests and Analysis

The Determination of the Mean

The arithmetic mean of all of the values assigned to each factor were determined. Each of these values was screened against 30, the pre-selected level of minimal concern, all of the means exceeded this value. Table 28 contains all of the mean values and lists them in descending order.

TABLE 28 FACTOR MEANS

Constructive	Mean	Virtual	Mean
Light Data	77.80	Light Data	75.70
Previous Use	70.40	Task	66.40
Task	68.30	Previous Use	65.70
Simulator	67.00	Terrain	65.50
Exercise Preparation	66.80	Friendly Equipment	64.40
Level Difficulty	66.30	Level Difficulty	63.10
Friendly Equipment	66.00	Simulator	62.80
Enemy Composition	65.90	Enemy Composition	61.60
Enemy Mission	65.70	Unit Assessment	61.40
Friendly Composition	65.48	Enemy Mission	60.20
Combat Power Ratio	64.70	Exercise Preparation	58.80
Terrain	64.50	Weather	58.70
Mission Planning	62.60	Combat Power Ratio	58.40
Enemy Equipment	58.50	Mission Planning	57.80
Enemy Task Organization	58.00	Observation Devices	57.00
Adjacent Unit	57.70	Enemy Equipment	55.80
Enemy Training Level	51.80	Adjacent Unit	55.10
Weather	51.50	Friendly Composition	53.60
Observation Devices	49.60	Enemy Training Level	51.70
Unit Assessment	48.30	Enemy Task Organization	51.40

(See Appendix L)

Analysis of Variance

A One Way Analysis of Variance was conducted in order to determine which factor's levels of probable impact on scenario selection were significantly larger or smaller than others. This analysis was conducted on the various population groupings and is summarized in Tables 29 through 35. The ANOVA revealed that some factors are more important than others and that this varies according to population group.

TABLE 29 ANOVA RESULTS: ALL RESPONDENTS

Population:	All Responses
Most Important Factors:	Constructive Unit Assessment
	Virtual Unit Assessment
	Constructive Previous Use of a Scenario
Least Important Factors:	Constructive Light Data
	Constructive Observation Devices
	Virtual Enemy Training Level

(See Appendix L)

TABLE 30 ANOVA RESULTS: ARMOR

Population:	Armor
Most Important Factors:	Virtual Unit Assessment
	Constructive Unit Assessment
Least Important Factors:	Constructive Light Data
	Constructive Weather

(See Appendix N)

TABLE 31 ANOVA RESULTS: AVIATION

Population:	Aviation
Most Important Factors:	Constructive Exercise Preparation
	Virtual Observation Devices
Least Important Factor:	Constructive Observation Devices

(See Appendix O)

TABLE 32 ANOVA RESULTS: INFANTRY

Population:	**Infantry**
Most Important Factors:	Constructive Task
	Constructive Terrain
Least Important Factor:	Virtual Exercise Preparation
	Constructive Observation Devices
	Virtual Enemy Training Level

TABLE 33 ANOVA RESULTS: MILITARY POLICE

Population:	**Military Police**
Most Important Factors:	Constructive Unit Assessment
	Virtual Unit Assessment
	Constructive Previous Use of a Scenario
Least Important Factors:	Virtual Terrain
	Virtual Observation Devices
	Virtual Light Data

(See Appendix R)

TABLE 34 ANOVA RESULTS: GROUND MANEUVER

Population:	Ground Maneuver
Most Important Factors:	Constructive Unit Assessment
	Virtual Unit Assessment
	Virtual Terrain
Least Important Factors:	Constructive Weather
	Constructive Observation Devices
	Constructive Enemy Training Level

(See Appendix T)

TABLE 35 ANOVA RESULTS: COMBAT SUPPORT AND COMBAT SERVICE SUPPORT

Population:	Combat Support and Combat Service Support
Most Important Factors:	Constructive Unit Assessment
	Virtual Unit Assessment
	Constructive Previous Use of a Scenario
Least Important Factors:	Virtual Enemy Training Level
	Virtual Observation Devices
	Virtual Enemy Training Level

(See Appendix U)

There were no factors significantly more likely to be considered for Air Defense, Chemical Corps, Corps of Engineers, Field Artillery, Ordinance, Quarter Master, Signal Corps, or Transportation Corps. This is could be a result of the small number of participants or because no factors are more significant than any others.

Refinement of the One Way ANOVA of the Combined Population

Many of the results are very close in value based on the confidence intervals around the means. Further examination of the factors can be done using a two tailed *z* statistic test for the difference between two means. Prior to the conducting this test it may be important to recognize the relationships between the variances. An F test of equal variances can determine this relationship. This relationship then ensures that the appropriate mean test is conducted.

$$F = \frac{s_1^2}{s_2^2}$$

Where

s_1^2 = *the variance of population 1*

s_2^2 = *the variance of population 2*

$df_{numerator} = n_1 - 1$

$df_{denominator} = n_2 - 1$ (equation 5)

The results of this analysis are shown in Table 36. The table shows that only 3 factors' means are equal to the Constructive Terrain Mean.

TABLE 36 REFINEMENT OF ANOVA: CONSTRUCTIVE TERRAIN

Factor Mean is Less than the Constructive Terrain Mean	Factor Mean is Equal to the Constructive Terrain Mean	Factor Mean is More than the Constructive Terrain Mean
Constructive Enemy Training Level	Constructive Enemy Task Organization	
Constructive Weather	Virtual Enemy Equipment	
Constructive Light Data	Virtual Adjacent Unit	
Constructive Observation Devices		
Virtual Friendly Composition		
Virtual Enemy Task Organization		
Virtual Enemy Training Level		

Comparing the Importance of the Constructive and Virtual Factors

A two tailed z statistic test for the difference between two means was conducted to determine the relative impact of Virtual and Constructive aspects of each factor for the total population. The surveys that did not include responses for each environment were eliminated from this analysis. The critical value for z in all of the tests was 1.96 (1.9599) at a 0.05 level of significance. Any test that produced a z statistic for which the absolute value exceeded 1.96 was determined to reject the hypothesis that the means were equal. Table 37 summarizes the results of the analysis. The environmental means were only

different for Light Data and Observation Devices . All results can be found in Appendix V.

TABLE 37 Z TEST: CONSTRUCTIVE VERSUS VIRTUAL

Means Are Not Equal	Means are Equal
Light Data	Terrain
Observation Devices	Task
	Simulator
	Friendly Composition
	Enemy Composition
	Combat Power Ratio
	Enemy Task Organization
	Enemy Equipment
	Friendly Equipment
	Adjacent Unit
	Enemy Training Level
	Enemy Mission
	Weather
	Previous Use
	Level Difficulty
	Unit Assessment
	Exercise Preparation
	Mission Planning

Though this type of test can be completed on any two factor value sets, an exhaustive analysis would require 2^{380} different combinations of factors and categories. All of the test results can be found in Appendix W.

Test for Independent Frequencies

All of the numerical responses given to each factor were categorized to produce Table 38. The table lists each factor and the number of responses for each category (Very Small Chance through Very High Chance):

TABLE 38 FACTOR FREQUENCIES FOR ALL RESPONDENTS

	Very Small Chance	Small Chance	Could Effect	High Chance	Very High Chance
Factor					
C Terrain	6	7	10	24	15
C Task	2	6	17	22	15
C Simulator	5	9	8	21	17
C F Comp	8	6	12	17	19
C E Comp	6	10	9	13	24
C Power Ratio	6	5	15	17	19
C Enemy Task Org	12	6	11	14	19
C E Equip	9	8	17	11	17
C F Equip	4	7	17	15	19
C Adjacent Unit	8	8	22	11	13
C E Train Level	13	10	15	14	10
C E Mission	6	7	11	18	20
C Weather	13	11	16	10	12
C Previous Use	2	5	16	19	20
C Difficulty	5	5	17	13	21
C Assessment	1	4	8	19	29
C Light Data	18	5	16	13	10
C Observation Devices	16	12	14	10	10
C Exercise Prep	6	8	7	21	20
C Mission Planning	9	9	9	14	21
V Terrain	6	4	8	15	17
V Task	3	7	11	14	15
V Simulator	7	6	9	11	16
V F Comp	11	9	9	9	12
V E Comp	5	10	8	13	14
V Power Ratio	5	7	18	11	9
V Enemy Task Org	12	6	12	9	11
V E Equip	10	4	12	14	10

	Very Small Chance	Small Chance	Could Effect	High Chance	Very High Chance
V F Equip	4	6	12	15	13
V Adjacent Unit	7	10	13	13	7
V E Train Level	13	7	9	11	10
Factor					
V E Mission	8	7	8	14	13
V Weather	9	3	16	9	13
V Previous Use	3	9	10	14	14
V Difficulty	5	7	13	10	15
V Assessment	5	3	4	9	28
V Light Data	10	4	14	10	12
V Observation Devices	8	6	11	9	16
V Exercise Prep	9	10	6	11	14
V Mission Planning	10	7	10	9	14

A chi-squared test for independence was then conducted to determine if the frequency that each factor was considered to be of a particular importance was independent of the environment under which it is considered. At the 0.05 level of significance none of the factors frequencies were effected by the environment. (Note the factor, Unit Assessment, could not be evaluated because more than 20% of the expected values were less than five (5). (All of the chi squared test results are in Appendix X.)

The same expected frequency sparseness problem arose with the examination of factor response frequency when comparing all of the factors, virtual and constructive, in terms of Ground Maneuver and CS and CSS. (See Ground Maneuver and CS and CSS Frequency Table in Appendix Y.) All of the resulting calculations produced more than 20% expected values under five (5). (See Appendix Z.)

In an effort to reduce the sparseness of the expected values the "Very Small Chance" and the "Small Chance" frequencies were combined into "Small". Similarly, "High Chance" and "Very High Chance" were combined into "High". The New frequency table appears in Appendix Z along with the frequency independence tests. Even after combining the ranges, many of the expected values remained less than five (5) and the factor's frequencies remained independent of the grouping, Ground Maneuver versus Combat Service and Combat Service Support. Table 39 summarizes these results.

TABLE 39 FREQUENCY TEST: GROUND MANEUVER VERSUS COMBAT SUPPORT AND COMBAT SERVICE SUPPORT

Factor frequency is independent of Ground Maneuver or CS & CSS	**More than 20% of the expected values are sparse (>5)**
Constructive	Constructive
Terrain	Task
Simulator	Combat Power Ratio
Friendly Composition	Enemy Equipment
Enemy Composition	Friendly Equipment
Enemy Task Organization	Adjacent Unit
Enemy Mission	Enemy Training Level
Previous Use	Weather
Difficulty	Light Data
Assessment	Observation Devices
Exercise Preparation	Mission Planning
Virtual	Virtual
Terrain	Combat Power Ratio
Task	Enemy Task Organization
Simulator	Enemy Equipment
Friendly Composition	Adjacent Unit
Enemy Composition	Light Data
Friendly Equipment	
Enemy Training Level	

Factor frequency is independent of Ground Maneuver or CS & CSS	More than 20% of the expected values are sparse (>5)
Enemy Mission	
Weather	
Previous Use	
Difficulty	
Assessment	
Observation Devices	
Exercise Preparation	
Mission Planning	

Assigning Weights to the Scenario Selection Factors

Two potential techniques exist for assigning weights to the various scenario selection factors. The first technique requires an exhaustive series of pair-wise comparisons of the factor means and variances. This method would result in groups of factors whose means could not be proven to be statistically different at a 0.05 level of significance. These factor-groups would then be assigned a weight or value derived from the means of all of the members of the group. This methodology would become quite cumbersome.

A far better approach is to address the issue of factor weights through the frequency table. The modal frequency group would determine the weight associated with the selection factor.

Table 40 is constructed by combining all of the frequency response data for environmental (constructive and virtual) and population (Ground Maneuver and Combat Service and Combat Service Support) groups. This can be done because the frequency analysis showed the responses to be independent of these associations.

TABLE 40 COMBINED CONSTRUCTIVE AND VIRTUAL FREQUENCY TABLE

	Very Small Chance	Small Chance	Could Effect	High Chance	Very High Chance
Factor					
Terrain	12	11	18	39	32
Task	5	13	28	36	30
Simulator	12	15	17	32	33
Friendly Composition	19	15	21	26	31
Enemy Composition	11	20	17	26	38
Combat Power Ratio	11	12	33	28	28
Enemy Task Organization	24	12	23	23	30
Enemy Equipment	19	12	29	25	27
Friendly Equipment	8	13	29	30	32
Adjacent Unit	15	18	35	24	20
Enemy Training Level	26	17	24	25	20
Enemy Mission	14	14	19	32	33
Weather	22	14	32	19	25
Previous Use	5	14	26	33	34
Difficulty	10	12	30	23	36
Assessment	6	7	12	28	57
Light Data	28	9	30	23	22
Observation Devices	24	18	25	19	26
Exercise Prep	15	18	13	32	34
Mission Planning	19	16	19	23	35

Table 41 is generated by selecting the modal value from Table 40.

TABLE 41 FACTOR WEIGHTS

	Very Small Chance (.1)	Small Chance (.3)	Could Effect (.5)	High Chance(.7)	Very High Chance(.9)
Factor					
Terrain				X	
Task				X	
Simulator					X
Friendly Composition					X
Enemy Composition					X
Combat Power Ratio			X		
Enemy Task Organization					X
Enemy Equipment			X		
Friendly Equipment					X
Adjacent Unit			X		
Enemy Training Level	X				
Enemy Mission					X
Weather			X		
Previous Use					X
Difficulty					X
Assessment					X
Light Data			X		
Observation Devices					X
Exercise Prep					X
Mission Planning					X

The data in Table 41 produces the Weight matrix $[W_{i,1}]$ of equation 3 as shown in figure 1:

$$
\left[W_{i,1}\right] = \begin{bmatrix} .7 \\ .7 \\ .9 \\ .9 \\ .9 \\ .5 \\ .9 \\ .5 \\ .9 \\ .5 \\ .1 \\ .9 \\ .5 \\ .9 \\ .9 \\ .9 \\ .5 \\ .9 \\ .9 \\ .9 \end{bmatrix}
$$

FIGURE 1: THE WEIGHT MATRIX

The Weight matrix is the final result of the survey data and analysis. All of the collected data is processed to produce this matrix that supports the multi-dimensional (METT-T factors) analysis of multiple simulation training scenarios.

Use of the System by a Potential User

As an example use of the system, consider the following: a user with the randomly assigned preferences, listed in Table 42, must decide between virtual simulation training scenario 1 (STS 1) or virtual simulation training scenario 2 (STS 2). The preferences in Table 42 are drawn from Tables 9 through 25 in chapter 3.

User Preference Matrix

TABLE 42 EXAMPLE USER PREFERENCES

Category	**Desired Value**	**UPC Value**
Particular task to be trained	Task number 1642	See Task matrix
Combat Power Ratio	Doctrinal	2
Enemy Composition	Tank Company	9
Enemy Task Organization	Advanced Guard	4
Enemy Equipment	No preference	0
Enemy Training Level	Standard	2
Enemy Mission	Attack	6
Exercise Preparation Time	Complete package	2
Mission Planning Time	No Preference	0
Terrain	Desert	1
Weather	Clear	6
Light Data	Dusk	4
Friendly Composition	Battalion	12
Friendly Equipment	Current	2
Adjacent Unit	U.S. Army	10
Supported Observation Devices	Thermal and Optical	2
Previous Use of a Scenario	No previous use	See Previous Use matrix
Level of Difficulty	Standard	2
Simulator	No Preference	0
Unit Assessment	Yes	See Untrained matrix

Table 42 is in reality a multi-dimensional table. For example, in order to determine $[U_{11}]$ one must use the Task matrix and the Scenario Task matrix. The intersection of matrices yields $[U_{11}]$.

Task Matrix

In the military, tasks are generally represented by a Mission Training Plan (MTP) number (Training Management, 1991). For this example 1642 represents the task "Occupy an Assembly Area". Since our fictional user desires to train his unit on task 1642, that task number is placed in the Task matrix, $[t_{ij}]$. The various tasks that are trained by the Simulation Training Scenarios (STS) appear in the respective Scenario Task matrices, $[T_{ij}]$.

The value of $[U_{1,1}]$ is determined by the intersection of the Task matrix, $[t_{i,j}]$. with the Scenario Task matrix $[T_{ij}]$ for each scenario.

$$[t_{i,j}] = [1642] \qquad [T_{ij}] \text{ for STS } 1 = \begin{bmatrix} 1352 \\ 1642 \\ 5429 \end{bmatrix} \qquad [T_{ij}] \text{ for STS } 2 = \begin{bmatrix} 1352 \\ 1142 \\ 2431 \end{bmatrix}$$

The values for $[U_{1,1}]$ for STS 1 is 0; the value for STS 2 is 1. This indicates that STS 1 contains the desired task while STS 2 does not.

Having determined the value of $[U_{11}]$, we must now consider the users desire not to repeat the use of a training scenario. This phase determines the value of $[U_{1,17}]$

Previous Use Matrix

The value of $[U_{1,17}]$ is determined by the relationship between the Previous Use matrix, $[P_{i,j}]$ and the scenario number. The Previous Use matrix, $[P_{i,j}]$ contains all of the numbers of the training scenarios the unit has previously executed. Because the user preferred not to reuse a scenario (see Table 42), the intersection of the sets are examined. If the intersection is the null set then $U_{1,17} = 0$, otherwise $U_{1,17} = 1$.

$[P_{i,j}]$ = [STS 3 STS 4 STS 2] therefore, the values for $[U_{1,17}]$ for STS 1 is 0 the value for STS 2 is 1.

Untrained Matrix

During the unit's training assessment process the unit is evaluated on its performance on various tasks. The unit is evaluated as trained on a task (T), needing practice (P), or untrained on the task (U) (Training Management, 1991). The MTP task numbers of the tasks that the unit is untrained in are placed in the Untrained Matrix $[F_{i,j}]$. This information is required to evaluate $[U_{1,20}]$.

Since the user desires to consider the unit's assessment, the intersection of the Scenario Task Matrix, $[T_{i,j}]$, and the Untrained Matrix, $[F_{i,j}]$ are examined.

$$[T_{ij}] \text{ for STS } 1 = \begin{bmatrix} 1352 \\ 1642 \\ 5429 \end{bmatrix} \qquad [T_{ij}] \text{ for STS } 2 = \begin{bmatrix} 1352 \\ 1142 \\ 2431 \end{bmatrix}$$

$[F_{ij}]$ for the unit $= \begin{bmatrix} 1476 \\ 1398 \\ 5429 \end{bmatrix}$ Therefore the values for $[U_{1,20}]$ for STS 1 is 0 the value for STS 2 is 1. This produces the following revised User Preference matrices:

U for STS 1 = [0 2 9 4 0 2 6 2 0 1 6 4 12 2 10 2 0 2 0 0]

U for STS 2 = [1 2 9 4 0 2 6 2 0 1 6 4 12 2 10 2 1 2 0 1]

With the evaluation of the of the final element of the User Preference Matrix it is necessary to evaluate the Difference Matrix with respect to the two simulation training scenarios.

The Scenario Characteristic Code Matrices

Table 43 summarizes the characteristics of the two training scenarios. The values for each category can be referenced from Tables 9 through 25 in chapter 3. By definition the values of $[S_{1,1}]$, $[S_{1,17}]$, $[S_{1,20}]$ are 0.

TABLE 43 SCENARIO CHARACTERISTIC CODES

Category	SCC for STS 1	SCC for STS 2
Particular task to be trained	0	0
Combat Power Ratio	2	2
Enemy Composition	8	9
Enemy Task Organization	4	4
Enemy Equipment	0	0
Enemy Training Level	2	2
Enemy Mission	6	6
Exercise Preparation Time	2	1
Mission Planning Time	0	0
Terrain	1	1
Weather	6	6
Light Data	4	4
Friendly Composition	12	12
Friendly Equipment	2	2
Adjacent Unit	10	10
Supported Observation Devices	2	2
Previous Use of a Scenario	0	0
Level of Difficulty	1	2
Simulator	0	0
Unit Assessment	0	0

Table 43 yields the following SCC for STS 1 and STS 2:

SCC for STS 1= [0 2 8 4 0 2 0 6 2 0 1 6 4 12 2 10 2 0 1 0 0]

SCC for STS 2= [0 2 9 4 0 2 0 6 1 0 1 6 4 12 2 10 2 0 2 0 0]

The Difference Matrix

The Difference matrix is formed by subtracting the SCC matrix from the UPC matrix. The Difference Matrix is a measure of the conceptual diastase between the simulation training scenario and the ideal simulation training scenario represented as :

$D_{Ideal} = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0]$

The comparison of the User Preference Matrices and the Scenario Characteristic Code Matrices yields the two Difference matrices:

$D_{i,j}$ for STS 1 = $[0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0]$

$D_{i,j}$ for STS 2 = $[1\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 0\ 0\ 1]$

The final [U] matrices are then defined as:

[U] for STS 1 = $[1\ 1\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 1\ 1]$

[U] for STS 2 = $[0\ 1\ 0\ 1\ 1\ 1\ 1\ 0\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 1\ 0]$

Both these matrices are then multiplied by the Weight matrix [W].

The Rank Matrix

The impact of the weight matrix is that it applies the relative importance of each dimension (factor) as determined by the survey analysis to the selection process.

Equation 3 results in the Rank Matrix. This number is a measure of the agreement between the users preferences and the candidate simulation training scenarios.

$$[R_{1,1}] = [u_{1,1}, u_{1,2} \ldots u_{1,20}] * \begin{bmatrix} w_{1,1} \\ w_{2,1} \\ \cdot \\ \cdot \\ w_{20,1} \end{bmatrix} = \left[\sum_{k=1}^{20} u_{1,k} w_{k,1} \right]$$

(equation 3)

$[R_{1,1}]$ for STS 1 = [12.5] =13.0

$[R_{1,1}]$ for STS 2 = [10.4] = 10.4

The larger value associated with STS 1 indicates that according to the users preferences, it is a better scenario for the required training.

Automated Sample Tool

The automated prototype tool is written using Microsoft Excel. The first screen, Figure 2, consists of the same User Preference matrix, Task matrix, Previous Use matrix, Untrained matrix, and Scenario Task matrices as in the above example. Due to the constraints of the prototype the matrices all appear in the form of [Element $_{I,1}$]. For all calculations the matrices were placed in their true form.

				STS 1		STS 2
Initial		Task		Scenario Task		Scenario Task
User Preference Matrix		Matrix		Matrix for STS 1		Matrix for STS 1
See Task matrix		1642		1352		1352
2				1642		1142
9				5429		2431
4						
0						
2				Value of U (1,1)		Value of U (1,1)
6				0		1
2						
0		Previous				
1		Use Matrix				
6		STS 3				
4		STS 4				
12		STS 2				
2						
10				Value of U (1,17)		Value of U (1,17)
2				1		0
See Previous Use matrix						
2		Untrained				
0		Matrix				
See Untrained matrix						
		1476				
		1398				
		5429				
				Value of U (1,20)		Value of U (1,20)
				0		1

FIGURE 2: AUTOMATED TOOL SCREEN 1

Figure 2 also shows the calculation of the values of $[U_{1,1}]$, $[U_{1,17}]$, and $[U_{1,20}]$ for both STS 1 and STS 2. They are calculated the same way as they were in the manual example.

Figure 3 shows the revised User Preference matrices along with the Scenario Characteristic Codes for STS 1 and STS 2. The Difference matrices are also calculated for the two simulation training scenarios.

Revised User Preference Matrix for STS 1		Revised User Preference Matrix for STS 2		SCC for STS 1		SCC for STS 2		Difference Matrix for STS 1	Difference Matrix for STS 2
0		1		0		0		0	1
2		2		2		2		0	0
9		9		8		9		1	0
4		4		4		4		0	0
0		0		0		0		0	0
2		2		2		2		0	0
6		6		6		6		0	0
2		2		2		1		0	1
0		0		0		0		0	0
1		1		1		1		0	0
6		6		6		6		0	0
4		4		4		4		0	0
12		12		12		12		0	0
2		2		2		2		0	0
10		10		10		10		0	0
2		2		2		2		0	0
0		1		0		0		0	1
2		2		1		2		1	0
0		0		0		0		0	0
0		1		0		0		0	1

FIGURE 3: AUTOMATED TOOL SCREEN 2

Figure 4 shows the Final User Preference matrices for the two simulation training scenarios, the Weight matrix as determined from the analysis, and the resulting Rank matrices for the two simulation training scenarios. The larger value for STS 1 indicates it is a better selection.

Final User Preference Matrix for STS 1		Final User Preference Matrix for STS 2		Weights Matrix		Rank Matrix for STS 1		Rank Matrix for STS 2
1		0		0.7		13.0		12.2
1		1		0.7				
0		1		0.9		**Select STS 1**		
1		1		0.9				
1		1		0.9				
1		1		0.5				
1		1		0.9				
1		0		0.5				
1		1		0.9				
1		1		0.5				
1		1		0.1				
1		1		0.9				
1		1		0.5				
1		1		0.9				
1		1		0.9				
1		1		0.9				
1		0		0.5				
0		1		0.9				
1		1		0.9				
1		0		0.9				

FIGURE 4: AUTOMATED TOOL SCREEN 3

Summary

The frequency based statistical analysis yielded the weights needed for the implementation strategy. This type of analysis eliminated any problems of parameteric assumptions. The Preference-Characteristic technique proved to be a valid technique by which to differentiate between scenarios. The simplicity of the method lent itself easily to manual manipulation and a prototype automated tool.

CHAPTER 7 FINDING, LESSONS LEARNED AND FUTURE RESEARCH

The intent of this effort was to investigate a methodology to determine factors for selecting training scenarios in virtual and constructive simulations. The research addressed this issue in four areas:

1. How is simulation training used, and what can be accomplished to streamline the simulation planning process?
2. What method of knowledge acquisition is most suitable for collecting information from a widely dispersed non-homogeneous population?
3. What means of analysis are the most appropriate for differentiating levels of significance between the selection factors?
4. How can this information be applied to the selection of simulation training scenarios?

Background

The effort to exploit the potential of simulation for improving task proficiency began in the early 1970's. The technology of the time limited most efforts to improvements in live simulation training. It was not until 1973 that the use of computer tools was harnessed to the effort. Constructive TES was the first computer based simulation training device.

The advancement in technology and the successful use of these initial training tools lead to the expansion of simulation training devices. Along with the explosion of computer based simulations was an order of magnitude explosion in the number of training scenarios. The number of scenarios became so unwieldy that numerous governmental review boards recommended that efforts be made to catalog them and place them in libraries.

To control this problem, the Army's latest major simulation program, the Combined Arms Tactical Trainer (CATT), developed SATS-TREDS. The Standard Army Training Schedule-Training Exercise Development System searches a scenario database and presents a prioritized list of appropriate scenarios. Members of the Army simulation and training community have also emphasized the need for adding additional types of searches. This type of automated scenario selection streamlines the simulation training planning process.

The intended user group is very diverse and geographically spread out. The need to contact a large number of members from each group drove the decision to use a survey to gather the information. The expense involved in conducting face to face interviews with SME's or utilizing Nominal Group Techniques makes use of these techniques prohibitive. If the information gathering could be coupled with other activities the expense is reduced.

Findings

The survey was conducted in two phases; an informal pilot phase used to develop and refine the survey instrument and a formal pilot where members of the targeted populations were solicited for their responses. The informal portion ensured that the instrument's questions addressed the appropriate issues and could be easily understood. During this phase the form and substance of the questions were changed to ensure that the correct information could be gathered. The data garnered from a pre-sampling exercise was also examined using the intended analysis techniques to ensure that the type of analysis was appropriate.

The formal pilot study gathered data from members of the target population. This formal exercise allowed the accumulation of representative data for analysis from the target population.

Two types of statistical analysis were applied to the data, mean based and frequency based. The mean based comparisons required a great deal of iterative calculations. These comparisons revealed statistical differences within populations and between environments. The expansive number of variables (2^{380}) makes this type of analysis too cumbersome for this application. Mean based comparisons would be appropriate for contexts which had fewer selection factors to compare.

The frequency based analysis was conducted using chi-squared tests to examine the frequency or preference levels. This analysis also revealed differences in factor

levels, but failed to determine differences in factors between the two environments. Though this type of analysis may not be as precise, it easily lends itself to quantification.

The quantified data can then be applied through a mathematical model that uses these weights to differentiate between previously equivalently ranked alternatives. An automated search can be accomplished by quantifying the characteristics of the scenarios and the users preferences against the same criteria. Simple mathematics and matrix comparisons and calculations can then be used to quantify the level of agreement between the scenarios and the users preferences. An example demonstrated and yielded a correct solution.

Lessons Learned

The most important lessons learned during this process from the aspect of the research are related to the distribution and analysis of the instrument. The survey process could have been improved by taking two significant steps. The most important step would be the early co-opting of an organization that controlled a large number of the members of the target population. If an organization could have been brought into the process at the survey design phase, this leverage could have been used to ensure better participation by respondents who had a stake in the analysis.

Early efforts to make the survey an on-line document or electronic form would have benefited the process. Placement of the survey on the world wide web, though

restricting access via a password, would have improved data collection and organization. Distributing the survey via electronic mail would have also improved the process. This step could have increased distribution, eased data categorization and analysis, and increased response rate.

The final lesson concerns the types of statistical analysis used to determine the weights. Better prior analysis of the informal pilot data would have revealed the exhaustive nature of means comparisons for such a large sample space. This effort would have lead to a much earlier focus on the frequency based statistical analysis. The frequency based analysis used in this research is the basis for the assignment of weights.

Further Research

Efforts should be made to implement this methodology in refining simulation scenario searches. Though the research was conducted within a military training environment, this methodology can be applied in any domain. The process of eliciting information from the user population, conducting discriminating analysis to determine levels of importance, and designing tools to automate the application of the knowledge can be beneficial in many situations.

Work can be continued on the studied problem as well. Based on the results of the pilot study, an effort should be made to gain wider distribution of the survey as an official Army survey. This could be accomplished in many ways. The Army Survey Office should be utilized to distribute the survey over a much wider range. This would require a formal proposal and funding for distribution, collection, and some automation of analysis. The survey could also be placed on line. Links could be placed on official Army web sites and the survey could be converted to an interactive document. The conversion to an interactive format would ease the problems of data tabulation and analysis. A great deal of effort would be required to coordinate for permission to establish links from other Army sites and to establish some kind of screening process to prevent unqualified respondents from contaminating the database.

Once data has been collected the selection methodology should be automated. The automated system could be integrated into the SATS, SATS-TREDS or any other

planning tool and other scenario library devices. Resource Consultants Incorporated is currently working on the Close Combat Tactical Trainer (CCTT) scenario library. In their design they have included a METT-T factor selection screen. There is currently no code or algorithms functioning based on the screen, but the interface could be easily modified to support scenario searches based on the methodology.

Further research could also be conducted into use of other scenario screening factors. The Battlefield Operating Systems, Combat Imperatives, Principles of War , and Combat Instruction Sets are also good candidates for selection factors. This same methodology could be applied to determine their importance.

The methodology is also applicable in any industry that utilizes simulation based training. The tool designer must establish valid candidate selection factors, collect and analyze data to determine the appropriate weights for those factors, categorize the scenario database and user preferences using those factors, and apply the Preference-Characteristic Matrix Technique.

Appendix A

Glossary

ANOVA	Analysis of Variance
AGTS	Advanced Gunnery Training Simulator
ARI	Army Research Institute
ARTEP	Army Training and Evaluation Plan
BBS	Brigade Battle Simulation
BDE	Brigade
BFDT	Board for Dynamic Training
BN	Battalion
CBS	Corps Battle Simulation
CATT	Combined Arms Tactical Trainer
CCTT	Close Combat Tactical Trainer
CTC	Combat Training Center
CS & CSS	Combat Support and Combat Service Support
df	Degrees of freedom
DIS	Distributed Interactive Simulation
GUARDFIST I	Call for Fire Trainer
HLA	High Level Architecture
HQDA	Headquarters Department of the Army
Janus	A constructive simulation
JCM	Joint Combat Model
LAN	Local Area Net

METL	Mission Essential Task List
METT-T	Mission, enemy, terrain, troops, and time
MTP	Mission Training Plan
MILES	Multiple Integrated Laser Engagement System
MTS	Moving Target Simulator
NGT	Nominal Group Technique
NTC	National Training Center at FT. Irwin
NTSA	National Training Systems Association
OPFOR	Opposing Forces
PCC	Preference-Characteristic Code
PDU	Protocol Data Unit
PM	Project Manager
REALTRAIN	Early vehicle/crew live simulation engagement trainer
REFORGER	Re-enforce Germany Training Exercise
SAF	Semi-automated Forces
SATS-TREDS	Standard Army Training System-Training Exercise Development System
SCC	Scenario Characteristic Code
SCOPES	Early small unit live simulation engagement trainer

SIMNET	Simulation Networking Trainer
SME	Subject Matter Expert
STS	Simulation Training Scenario
TADSS	Training Aides, Devices, Simulators and Systems
TPS Codes	Task Performance Support
TES	Tactical Engagement System
TWGSS	Tank Weapons Gunnery Simulation System
UCOFT	Unit Conduct of Fire Trainer
UPC	User Preference Code

Appendix B

User Preference Code and Scenario Characteristic Code Elements

TABLE 9 $U_{1,2}$ $S_{1,2}$ VALUES

User Preference	Value of $U_{1,2}$
CPR> doctrinal level	3
CPR = doctrinal level	2
CPR< doctrinal level	1
No Preference	0

TABLE 10 $U_{1,3}$ $S_{1,3}$: VALUES

User Preference	Value of $U_{1,3}$
Motorized Rifle Division	16
Motorized Rifle Regiment	15
Motorized Rifle Battalion	14
Motorized Rifle Company	13
Tank Division	12
Tank Regiment	11
Tank Battalion	10
Tank Company	9
Airborne Division	8
Air Assault Brigade	7
Air Mobile Assault Brigade	6
Infantry Pure	5
Armor Pure	4
Aviation Pure	3
Air Defense Pure	2
Field Artillery Pure	1
No Preference	0

TABLE 11 $U_{1,4}$ $S_{1,4}$ VALUES

User Preference	Value of $U_{1,4}$
Main Body	6
Forward Security Element	5
Advanced Guard	4
Mobile Obstacle Detachment	3
Command Post	2
Reconnaissance Element	1
No Preference	0

TABLE 12 $U_{1,5}$ $S_{1,5}$ VALUES

User Preference			**Value of $U_{1,5}$**
Tank	Infantry	Tactical Air	
T-80	BMP-3	Holkum	5
Any one of the above but not all three			4
T-72	BMP-2	Hind series	3
Any one of the above but not all three			2
Other			1
No Preference			0

TABLE 13 $U_{1,6}$ $S_{1,6}$ VALUES

User Preference	**Value of $U_{1,6}$**
Enhanced Probability of Hit, Kill, or Detection	3
Standard Probability of Hit, Kill, or Detection	2
Depressed Probability of Hit, Kill, or Detection	1
No Preference	0

TABLE 14 $U_{1,7}$ $S_{1,7}$ VALUES

User Preference	**Value of $U_{1,7}$**
Offensive Operations	
Attack	6
Meeting Engagement	5
Pursuit	4
Defensive Operations	
Hasty Defense	3
Prepared Defense	2
Withdrawal	1
No Preference	0

TABLE 15 $U_{1,8}$ $S_{1,8}$ VALUES

User Preference	Value of $U_{1,8}$
Complete Training Support Package	2
Partial Training Support Package	1
No Preference	0

TABLE 16 $U_{1,9}$ $S_{1,9}$ VALUES

User Preference	Value of $U_{1,9}$
Unit Required to Execute Supplied Orders	2
Unit must Execute the Mission Planning Process	1
No Preference	0

TABLE 17 $U_{1,10}$ $S_{1,10}$ VALUES

User Preference	Value of $U_{1,10}$
Mountainous	6
Swamp	5
Jungle	4
Wooded	3
Rolling Hills	2
Desert	1
No Preference	0

TABLE 18 $U_{1,11}$ $S_{1,11}$ VALUES

User Preference	Value of $U_{1,11}$
Clear	6
Light Rain	5
Rain	4
Snow	3
Fog	2
Sleet/Icy	1
No Preference	0

TABLE 19 $U_{1,12}$ $S_{1,12}$ VALUES

User Preference	Value of $U_{1,12}$
Daylight	5
Dusk	4
Night (Moon)	3
Night (No moon)	2
Dawn	1
No Preference	0

TABLE 20 $U_{1,13}$ $S_{1,13}$ VALUES

User Preference	Value of $U_{1,13}$
Brigade	14
Task Force	13
Battalion	12
Squadron	11
Company	10
Battery	9
Troop	8
Platoon	7
Section	6
Detachment	5
Squad	4
Crew	3
Team	2
No Preference	0

TABLE 21 $U_{1,14}$ $S_{1,14}$ VALUES

User Preference	Value of $U_{1,14}$
Current Table of Organization and Equipment	2
Other	1
No Preference	0

TABLE 22 $U_{1,15}$ $S_{1,15}$ VALUES

User Preference	Value of $U_{1,15}$
United States Army	10
United States Marines	9
British	8
German	7
Kuwaiti	6
Saudi Arabian	5
French	4
Canadian	3
Korean	2
Other	1
No Preference	0

TABLE 23 $U_{1,16}$ $S_{1,16}$ VALUES

User Preference	Value of $U_{1,16}$
All Imaging Equipment	4
Radar, Thermal, and Optical	3
Thermal and Optical	2
Optical	1
No Preference	0

TABLE 24 $U_{1,18}$ $S_{1,18}$ VALUES

User Preference	Value of $U_{1,18}$
More Difficult	3
Standard	2
Less Difficult	1
No Preference	0

TABLE 25 $U_{1,19}$ $S_{1,19}$ VALUES

User Preference	Value of $U_{1,19}$
AGTS	14
BBS	13
CBS	12
CCTT	11
Driver Trainer	10
JANUS	9
JCM	8
MTS	7
Pilot Trainer	6
SIMNET	5
GUARDFIST I	4
TSFO	3
UCCATS	2
UCOFT	1
No Preference	0

Appendix C

Survey Questions' Intent

This section is designed to collect the demographic data that will determine if the respondent is qualified to respond to the questionnaire. It can also be used to differentiate the different sub-groups of the respondent population.

Please answer the following questions. All information will be kept in strict confidence. Only aggregate data will be reported.

A. General

Name (optional): ______________________ Branch:_______ Rank:_____

Unit_______ Current Duty Position:____________ Last Level of Command:_________

Military Education Level:________ Age:_____ Time in Service:______

Time in Unit_______ Previous duty positions over the last five years:___________________

____

____

B. Training and Simulation

For the following questions, circle the most appropriate response.

1. If you related your unit training experience in terms of years, where would you place yourself on the chart below ?

less than 5 years	6 - 10 years	11 - 15 years	16 - 21 years	over 21 years

2. In the last year, how much total time have you/your staff spent planning simulation based training?

less than 10 hours	11-20 hours	21 - 30 hours	31 - 40 hours	over 41 hours

3. In the last year, how much time has your unit spent executing simulation based training?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

4. Of your simulator training time, how much is in a virtual environment (SIMNET, UCOFT, Flight Trainer, etc.)?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

5. Of your simulator training time, how much is in a constructive environment (JANUS, BBS, CSSTSS, CBS, etc.)?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

6. How effective do you believe simulation based training is in preparing your unit for war?

Not effective 0-20%	Somewhat ineffective 21-40%	Effective 41-60%	Highly effective 61-80%	Very highly effective 81-100%

Question 7 will elicit the simulators with which the subject has trained. The subjects estimation of effectiveness may also indicate biases. All acronyms are included in the glossary.

7. Which simulations or simulator devices have you or your unit trained with, and how would you evaluate their effectiveness? (Please check)

Simulator	I or my unit have trained with this simulator	Not effective 0-20%	Somewhat ineffective 21-40%	Effective 41-60%	Highly effective 61-80%	Very Highly Effective 81-100%
AGTS						
BBS						
CBS						
CCTT						
Driver Trainer						
JANUS						
JCM						
MTS						
Pilot Trainer						
SIMNET						
GUARDFIST I						
TSFO						

ADDITIONAL COMMENTS:

All of these questions refer to factors that may or may not influence your selection of training scenarios to be utilized in constructive and virtual simulations. Please answer them by placing a numerical value corresponding to your level of belief that you would use each factor in selecting a training scenario. You may use any value between 0 and 100. The scale below is meant only as a guide. You are to give answers for both **virtual** and **constructive** environments. It may help to imagine that you are planning virtual (SIMNET, UCOFT, PGT, CCTT, Pilot trainer, etc.) and constructive (JANUS, BBS, CBS, etc.) training exercises. What are the chances you consider these factors?

The scale is designed to help the respondent to focus his response. The use of the numerical and verbal scale eliminates ambiguity.

Very Small Chance 0-20%	Small Chance 21-40%	Could Effect 41-60%	High Chance 61-80%	Very High Chance 81-100%

1. How much does the type of terrain (desert, rolling hills, restrictive, etc.) affect your scenario selection?

INTENT: *To determine the value the battle space landform has on the selection*

EFFECT: *If this factor is not important then scenarios do not need to be created on terrain bases representing the different geographic operational areas. This will reduce the number of scenarios significantly and eliminate the need to produce variants for different theaters.*

If this factor is important the scenario library must contain a variant of every mission on each terrain base.

Keyed: *Terrain is currently tracked in the training support package.*

2. How much does one particular task to be trained (individual through collective) affect your scenario selection?

INTENT: *To determine if a particular task can effect the scenario selection.*

EFFECT: *If this factor is not important then the current task list comparison used in SATS-TREDS is acceptable. The most matches between the desired task list and the training scenario's supported task list is desirable.*

If this factor is important the search criteria must be altered so that a

training scenario must include the "key" task to be acceptable.

Keyed: *Supported training tasks are currently tracked in the training support package.*

3. How much does the simulator type (JANUS, CBS, BBS, SIMNET, CCTT etc.) affect your scenario selection?

INTENT: *To determine the value of limiting the search to a particular simulator.*

EFFECT: *If this factor is not important then all of the scenarios must be examined. This would be useful for long term planning before resources constraints are considered. This would allow the trainer to select the best scenario available to train the desired tasks and then look to resource that plan.*

If this factor is important the training planner must consider resource constraints prior to refining his search.

Keyed: *Each simulation type is currently tracked in the training support package.*

4. How much does the friendly unit's composition (pure or combined arms) affect your scenario selection?

INTENT: *To determine the value the friendly units make up has on the selection.*

EFFECT: *If this factor is not important then the library will be searched without regard to friendly force structure.*

If this factor is important the search will have to consider the types of units and the types of vehicle crew configurations that the scenario is designed to support.

Keyed: *Friendly unit's composition is currently tracked in the training support package.*

5. How much does the enemy unit's composition/capabilities (motorized, light, armored, attack aviation, etc.) affect your scenario selection?

INTENT: *To determine the value of enemy's characteristics on the selection.*

EFFECT: *If this factor is not important then very generic enemy force templates can be created. Such templates could be built on battalion, regiment, division and corps frameworks and be associated with any terrain and task list.*

If this factor is important the scenario library must contain a variant of every mission on each terrain base.

Keyed: *Enemy unit's composition/capabilities are currently tracked in the training support package.*

6. How much does the enemy/friendly combat power ratio affect your scenario selection?

INTENT: *To determine the value combat power ratios have on the selection.*

EFFECT: *If this factor is not important then generic enemy force templates may be inserted in any scenario in the library.*

If this factor is important the doctrinally correct combat power ratios should be referenced in the scenario selection.

Keyed: *Combat power ratio is not currently tracked in the training support package.*

7. How much does the enemy's task organization affect your scenario selection?

INTENT: *To determine the value the enemy's task organization on the selection.*

EFFECT: *If this factor is not important then enemy combat elements such as the regimental recon, advanced guard, or a motorized rifle regiment can be standardized with little need to adjust later.*

If this factor is important the scenario library must contain variations of enemy force structure.

Keyed: *Enemy force structure is not currently tracked in this form.*

8. How much does enemy equipment (T-62 vs. T-72 or Hind-D vs. Holkum) affect your scenario selection?

INTENT: *To determine the value enemy equipment types have on the selection.*

EFFECT: *If this factor is not important then scenarios can be created with "typical" enemy equipment. This will reduce the size of the data base required to support the simulations.*

If this factor is important the scenario library must track scenario variants with different enemy equipment. . This causes a need for a larger data base to support the simulation and the ability to add or modify equipment in the scenario.

Keyed: *Enemy equipment is currently tracked in the training support package.*

Keyed: *Enemy equipment is currently tracked in the training support package.*

9. How much does friendly equipment (M60 vs. M1A2 or Cobra vs. Apache Longbow) affect your scenario selection?

INTENT: *To determine the value friendly unit equipment has on the selection.*

EFFECT: *If this factor is not important all of the scenarios can be built with "typical" friendly equipment. This will reduce the size of the data base associated with the simulations.*

If this factor is important the scenario library must be built to accommodate different friendly equipment types. This causes a need for a larger data base to support the simulation and the ability to add or modify equipment in the scenario.

Keyed: *Friendly equipment is currently tracked in the training support package.*

10. How much does adjacent friendly unit equipment (M60 vs. M1A2 or Cobra vs. Apache Longbow) affect your scenario selection?

INTENT: *To determine the value adjacent friendly unit equipment types have on the selection. This will support the simulation of multinational forces fighting in adjacent areas of the battle field.*

EFFECT: *If this factor is not important all of the scenarios can be built with "typical" friendly equipment. This will reduce the size of the data base associated with the simulations*

If this factor is important the scenario library must be built to accommodate different equipment types. This causes a need for a larger data base to support the simulation and the ability to add or modify equipment in the scenario. This will also drive the need to depict all equipment types in a "friendly" and "enemy" mode.

Keyed: *Adjacent unit equipment is not clearly defined in the training support package.*

11. How much does the enemy's training level affect your scenario selection?

INTENT: *To determine the value the enemy's training level has on the selection.*

EFFECT: *If this factor is not important standard values for enemy training indicators such as the time to acquire a target and the rate of fire of a weapon system can be incorporated in all of the scenarios.*

If this factor is important these training indicators must be coded in such a way that they can be changed for particular units in a given scenario (perhaps for recently reconstituted units). They may be able to be correlated to a level of difficulty associated with the scenario.

Keyed: *The enemy's training level is not currently tracked in the training support package.*

12. How much does the enemy's mission affect your scenario selection?

INTENT: *To determine the value the enemy's mission has on the selection.*

EFFECT: *If this factor is not important it will reduce the number of scenarios that need to be maintained in the library.*

If this factor is important the number of scenarios will increase substantially. The library will need to contain all combinations of friendly unit missions versus enemy unit missions for all other factors that are significant.

Keyed: *The enemy's mission is currently tracked in the training support package.*

13. How much does weather (fog, rain, or haze) affect your scenario selection?

INTENT: *To determine the value weather has on the selection.*

EFFECT: *If this factor is not important weather effects can be either removed from the scenarios or added as a random variable dependent on the terrain form being utilized.*

If this factor is important the scenario library must contain scenario variations that duplicate the weather patterns associated with the terrain forms. It would also become necessary to enable the trainer to modify weather conditions on demand within the scenario.

Keyed: *Weather is not currently tracked in the training support package.*

14. How much does previous use of a scenario affect your scenario selection?

INTENT: *To determine the value previous use of a scenario have on the selection. This will support the desire of a commander to expose his soldiers to new conditions under which to practice a task. Or the ability to re-train a soldier/unit on an important scenario with which they have had*

difficulty in the past.

EFFECT: *If this factor is not important no preference will be given to a scenario based on its prior use or lack of use.*

If this factor is important the simulation selection tool must record previous use of a scenario at the soldier or unit level as well as the trainer preference for re-use.

Keyed: *The previous use of a scenario is not currently tracked in the training support package.*

15. How does the level of difficulty of the exercise affect your scenario selection?

INTENT: *To determine the value the level of difficulty of the exercise has on the selection. This factor would allow commanders to execute crawl, walk, run training with their units more easily. It would also allow soldiers/units to retrain on tasks they have had difficulty executing at an easier level.*

EFFECT: *If this factor is not important no changes need to be made to the current selection technique.*

If this factor is important an algorithm for determining the level of difficulty for a simulation exercise must be developed. The algorithm must consider as a minimum simulator and mission. This information would then have to be coded for the search.

Keyed: *The level of difficulty of the exercise is not currently tracked in the training support package.*

16. How much does unit past performance assessment (T's, P's, and U's) affect you scenario selection?

INTENT: *To determine the value unit past performance assessment has on the selection.*

EFFECT: *If this factor is not important there is no need to reference training assessment during selection.*

If this factor is important it would have to be associated with a priority list. A commander would need to prioritize mission essential task list (METL) elements according to their assessment. This would affect the selection of the scenario both in terms of supported tasks and level of difficulty. (You would not want to have an untrained unit attempt to execute a task under the most difficult conditions.)

Keyed: *Unit past performance assessment is currently tracked by the SATS-TREDS tool.*

17. How much do light conditions (daylight, night, % illumination, etc.) affect your scenario selection?

INTENT: *To determine the value light conditions have on the selection.*

EFFECT: *If this factor is not important then each scenario can be established with a single time(local noon or midnight). This reduces the computational load on the simulator with the factors affected by lighting(shadow, detection, etc.) Only scenarios that included tasks that required darkness would be constructed to include night.*

If this factor is important each scenario would have to be built with a scenario time clock. This would require the simulator to make calculations based on position of the sun and the moon. This adds computational a load to the system. The clock would need to be adjustable to be able to start the scenario at any scenario local time.

Keyed: *Light conditions are not currently tracked in the training support package outside of tasks such as "Conduct night attack."*

18. How much does the capability to support observation devices (FLIR, Thermal, NVG, Optic, etc.) and their degradation affect your scenario selection?

INTENT: *To determine the value the capability to support observation devices has on the selection.*

EFFECT: *If this factor is not important the scenarios can be used by nits that have all versions of the same equipment. This reduces the number of scenarios and their configurations.*

If this factor is important scenarios have to be built maintained specifically to support each improvement in sensing.

Keyed: *The capability to support observation devices is currently tracked by the type of simulator.*

19. How much does the amount of exercise preparation required (placement of forces on the battle field, coordination of simulation facility use, and other administrative tasks associated with the training) affect your scenario selection?

INTENT: *To determine the value the amount of exercise preparation required has on the selection. This affects the quality of the training support package*

needed to accompany each scenario.

EFFECT: *If this factor is not important then each scenario/training support package must be built to a predetermined level of completeness. The level of completeness addresses items such as unit placement on the land forms, unit scheduling, and training schedule planning.*

If this factor is important then all scenarios must still be built to a set standard, but certain scenario's should have placement and coordination data that can be used to support the training. This may be important for reserve and national guard units that may not have the resources and time to do a complete training cycle.

Keyed: *The amount of exercise preparation required is not currently tracked in the training support package.*

21. How much does the amount of mission planning required (troop leading procedures, course of action development, OPORD preparation) affect your scenario selection?

INTENT: *To determine the value the amount of mission planning required has on the selection.*

EFFECT: *If this factor is not important the all scenarios will be built to allow the trained unit to conduct a complete planning cycle. The TSP will include a complete higher headquarters' operations order (OPORD).*

If this factor is important then some scenario TSP's will include complete orders and execution matrixes for the higher unit, the trained unit and any other elements taking part in the training. This will allow some units who lack planning time to train on operational execution.

Keyed: *The amount of mission planning required is currently tracked in the training support package.*

22. Please list below any other factors that affect your scenario selection?

FACTOR:______________________________

INTENT: *To determine if other potentially important factors affecting scenario selection have been left out of the survey.*

EFFECT: *If factors are repeatedly noted on the form or seem particularly applicable to the process they will be included on the survey used in the definitive study.*

Keyed: *Not applicable*

Additional Comments:

Appendix D

Survey's Initial Form

Date ____________

Please answer the following questions by circling your response. All information will be kept in strict confidence. Only aggregate data will be reported.

A. General

Name (optional): ______________________ Branch:________ Rank:______

Current Duty Position:____________ Last Level of Command:__________

Military Education Level:_________ Age:______ Time in Service:_______

Time in Unit_______ Previous duty positions over the last five years:____________

____

B. Training and Simulation

1. If you related your unit training experience in terms of years where would you place yourself on the chart below ?

less than 5 years	6 - 10 years	11 - 15 years	16 - 21 years	over 21 years

2. In the last year, how much time have you/your staff spent planning simulation based training?

less than 10 hours	11-20 hours	21 - 30 hours	31 - 40 hours	over 41 hours

3. In the last year, how much time has your unit spent in simulator based training?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

4. Of your simulator training time, how much is in a virtual environment (SIMNET, UCOFT, Flight Trainer etc.)?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

5. Of your simulator training time, how much is in a constructive environment (JANUS, BBS, CSSTSS, CBS, WARSIM, etc.)?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

6. Does your unit use simulation as a capstone training event?

Yes_____ No_____

7. Which simulations or simulator devices have you, personally, trained with, and how would you evaluate their effectiveness? (Please check.)

Simulator	I have personally trained with this simulator	Not effective 0-20%	Somewhat ineffective 21-40%	Effective 41-60%	Highly effective 61-80%	Very Highly Effective 81-100%
AGTS						
BBS						
CBS						
CCTT						
Driver Trainer						
JANUS						
JCM						
MTS						
Pilot Trainer						
SIMNET						
STOW(E)						
TSFO						
UCCATS						
UCOFT						
OTHERS:						

ADDITIONAL COMMENTS:

The following questionnaires are designed to determine what factors effect a commander's or operations officer's selection of a simulation training scenario. The intent is to determine which factors or properties are the most important for virtual simulations, such as CCTT, and which are most important for constructive simulations, such as JANUS or CBS.

The factors that are determined to be the most important will be converted to an expert system that will be incorporated into SATS-TREDS. As part of SATS-TREDS, the commander will be able to tailor them to aid in selecting the appropriate training scenario from the army's simulation library. The selection process will be interactive; the commander will be presented with 5 or 6 scenarios that closely meet his needs. Each choice's strengths will be highlighted to help the commander make his decision.

The separate questionnaires allow the commander to emphasize factors that he thinks can be better trained in each environment.

Date ____________

Name (optional) ______________________ Branch______ Rank_____
Current Duty Position________________
Previous duty positions over the last five years_________________________________
____

All of these questions refer to factors that may or may not influence your selection of training scenarios to be utilized in constructive simulations. Please answer them by placing a numerical value corresponding to your level of belief that you would use each factor in selecting a training scenario. You may use any value between 0 and 100. The scale below is meant only as a guide.

Very Small Chance	Small Chance	Could Effect	High Chance	Very High Chance
0-20%	21-40%	41-60%	61-80%	81-100%

1. How much does the type of terrain (dessert, rolling hills, restrictive etc.) affect your selection?

Value ☐

2. How much does one particular task affect your selection?

Value ☐

3. How much does the simulator selection (JANUS, CBS, BBS etc.) affect your selection?

Value ☐

4. How much does the friendly unit's composition (pure or combined arms) affect your selection?

Value ☐

5. How much does the enemy unit's composition/capabilities (motorized, light, armored, attack aviation etc.) affect your selection?

Value ☐

6. How much does the enemy/friendly ratio affect your selection?

Value

7. How much does enemy equipment (T-62 vs. T-72 or Hind D vs. Holkum) affect your selection?

Value

8. How much does friendly equipment (M60 vs. M1A2 or Cobra vs. Apache Longbow) affect your selection?

Value

9. How much does friendly bordering unit equipment (M60 vs. M1A2 or Cobra vs. Apache Longbow) affect your selection?

Value

10. How much does enemy's training level affect your selection?

Value

11. How much does enemy's strength level affect your selection?

Value

12. How much does the enemy's mission affect your selection?

Value

13. How much does weather affect your selection?

Value

14. How much does previous use of a scenario affect your selection?

Value

15. Please list below any other factors that effect your scenario selection.

FACTOR:______________ Value [ ]

FACTOR:______________ Value [ ]

FACTOR:______________ Value [ ]

FACTOR:______________ Value [ ]

Additional Comments:

Date ____________

Name (optional) ______________________ Branch_______ Rank______
Current Duty Position_________________
Previous duty positions over the last five years__________________________________

____

All of these questions refer to factors that may or may not influence your selection of training scenarios to be utilized in virtual environment such as SIMNET or CCTT. Please answer them by placing a numerical value corresponding to your level of belief that you would use each factor in selecting a training scenario. You may use any value between 0 and 100. The scale below is meant only as a guide.

Very Small Chance	Small Chance	Could Effect	High Chance	Very High Chance
0-20%	21-40%	41-60%	61-80%	81-100%

1. How much does the type of terrain (dessert, rolling hills, restrictive etc.) affect your selection?

Value

2. How much does the light condition (daylight, night, % illumination, etc.) affect your selection?

Value

3. How much does one particular task affect your selection?

Value

4. How much does the simulator selection (CCTT, SIMNET etc.) affect your selection?

Value

5. How much does the friendly unit's composition (pure or combined arms) affect your selection?

Value

6. How much does the enemy unit's composition/capabilities (motorized, light, armored, attack aviation etc.) affect your selection?

Value

7. How much does the enemy/friendly ratio affect your selection?

Value

8. How much does the existence of pre-planned fires affect your selection?

Value

9. How much does enemy equipment (T-62 vs. T-72 or Hind D vs. Holkum) affect your selection?

Value

10. How much does friendly equipment (M60 vs. M1A2 or Cobra vs. Apache Longbow) affect your selection?

Value

11. How much does friendly bordering unit equipment (M60 vs. M1A2 or Cobra vs. Apache Longbow) affect your selection?

Value

12. How much does enemy's training level affect your selection?

Value

13. How much does enemy's strength level affect your selection?

Value

14. How much does the enemy's mission affect your selection?

Value

15. How much do thermal conditions affect your selection?

Value

16. How much does fog, rain or haze affect your selection?

Value

17. How much does previous use of a scenario affect your selection?

Value

18. Please list below any other factors that effect your scenario selection.

FACTOR:______________ Value [ ]

FACTOR:______________ Value [ ]

FACTOR:______________ Value [ ]

FACTOR:______________ Value [ ]

ADDITIONAL COMMENTS:

Appendix E

Survey's Final Form

The following questionnaire is designed to determine what factors affect a commander's or operations officer's selection of a simulation training scenario. The **S**tandard **A**rmy **T**raining **S**ystem-**TR**aining **E**xercise **D**evelopment **S**ystem (SATS-TREDS) currently selects scenarios based on the desired MTP tasks that the commander wants trained. These selected tasks determine the training audience. The intent is to determine which additional factors or properties are the most important for virtual simulations, such as SIMNET, and which are most important for constructive simulations, such as JANUS or CBS. A general definition of a virtual training simulation is a training device where the trainee is immersed in a computer generated environment designed to replicate conditions and react to stimuli accurately mimicking the real world (battlespace). A constructive training simulation can be defined as computer generated people, units, and equipment operating in a synthetic battle, where the trainee(s) interacts through computer terminals, screens and other similar devices. The trainees may be insulated from the computer architecture by means of organic unit reporting systems.

The most important factors will be modeled in an expert system within SATS-TREDS. As part of SATS-TREDS, the commander will be able to tailor the factors to aid in selecting the appropriate training scenario from the Army's simulation library. The selection process will be interactive; the commander will be presented with 5 or 6 scenarios that closely meet his needs. Each choice's strengths will be highlighted to help the commander make his decision.

Indicate the impact each factor has on the environment by placing values for virtual simulations in the triangle and the responses for constructive simulations in the square.

Value △	Value □
Virtual	**Constructive**

Please respond for the two types of simulations: virtual (SIMNET, COFT, etc.) and constructive (Janus, BCTP, etc.). Your responses are independent for each category. For example: there is no reason you cannot assign a score of "100" to both types of simulations for the factor "Terrain".

Please answer the following questions. All information will be kept in strict confidence. Only aggregate data will be reported.

A. **General**

Name (optional): ____________________ Branch:________ Rank:______

Unit________ Current Duty Position:____________ Last Level of Command:__________

Military Education Level:_________ Age:______ Time in Service:_______

Time in Unit________ Previous duty positions over the last five years:______________________

____

____

B. **Training and Simulation**

For the following questions, circle the most appropriate response.

1. If you related your unit training experience in terms of years, where would you place yourself on the chart below ?

less than 5 years	6 - 10 years	11 - 15 years	16 - 21 years	over 21 years

2. In the last year, how much total time have you/your staff spent planning simulation based training?

less than 10 hours	11-20 hours	21 - 30 hours	31 - 40 hours	over 41 hours

3. In the last year, how much time has your unit spent executing simulation based training?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

4. Of your simulator training time, how much is in a virtual environment (SIMNET, UCOFT, Flight Trainer, etc.)?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

5. Of your simulator training time, how much is in a constructive environment (JANUS, BBS, CSSTSS, CBS, etc.)?

less than 1 day	1-5 days	6-10 days	10-15 days	over 16 days

6. How effective do you believe simulation based training is in preparing your unit for war?

Not effective 0-20%	Somewhat ineffective 21-40%	Effective 41-60%	Highly effective 61-80%	Very highly effective 81-100%

7. Which simulations or simulator devices have you or your unit trained with, and how would you evaluate their effectiveness? (Please check)

Simulator	I or my unit have trained with this simulator	Not effective 0-20%	Somewhat ineffective 21-40%	Effective 41-60%	Highly effective 61-80%	Very Highly Effective 81-100%
AGTS						
BBS						
CBS						
CCTT						
Driver Trainer						
JANUS						
JCM						
MTS						
Pilot Trainer						
SIMNET						
GUARDFIST I						
TSFO						
UCCATS						
UCOFT						
OTHERS:						

ADDITIONAL COMMENTS:

All of these questions refer to factors that may or may not influence your selection of training scenarios to be utilized in constructive and virtual simulations. Please answer them by placing a numerical value corresponding to your level of belief that you would use each factor in selecting a training scenario. You may use any value between 0 and 100. The scale below is meant only as a guide. You are to give answers for both **virtual** and **constructive** environments. It may help to imagine that you are planning virtual (SIMNET, UCOFT, PGT, CCTT, Pilot trainer, etc.) and constructive (JANUS, BBS, CBS, etc.) training exercises. What are the chances you consider these factors?

Very Small Chance	Small Chance	Could Effect	High Chance	Very High Chance
0-20%	21-40%	41-60%	61-80%	81-100%

1. How much does the type of terrain (desert, rolling hills, restrictive, etc.) affect your scenario selection?

Value △ Value □

Virtual **Constructive**

2. How much does one particular task to be trained (individual through collective) affect your scenario selection?

Value △ Value □

Virtual **Constructive**

3. How much does the simulator type (JANUS, CBS, BBS, SIMNET, CCTT etc.) affect your scenario selection?

Value △ Value □

Virtual **Constructive**

4. How much does the friendly unit's composition (pure or combined arms) affect your scenario selection?

Value △ Value □

Virtual **Constructive**

Very Small Chance 0-20%	Small Chance 21-40%	Could Effect 41-60%	High Chance 61-80%	Very High Chance 81-100%

5. How much does the enemy unit's composition/capabilities (motorized, light, armored, attack aviation, etc.) affect your scenario selection?

Value **Virtual** Value **Constructive**

6. How much does the enemy/friendly combat power ratio affect your scenario selection?

Value **Virtual** Value **Constructive**

7. How much does the enemy's task organization affect your scenario selection?

Value **Virtual** Value **Constructive**

8. How much does enemy equipment (T-62 vs. T-72 or Hind-D vs. Holkum) affect your scenario selection?

Value **Virtual** Value **Constructive**

9. How much does friendly equipment (M60 vs. M1A2 or Cobra vs. Apache Longbow) affect your scenario selection?

Value **Virtual** Value **Constructive**

10. How much does adjacent friendly unit equipment (M60 vs. M1A2 or Cobra vs. Apache Longbow) affect your scenario selection?

Value Value

Virtual **Constructive**

Very Small Chance 0-20%	Small Chance 21-40%	Could Effect 41-60%	High Chance 61-80%	Very High Chance 81-100%

11. How much does the enemy's training level affect your scenario selection?

Value Value

Virtual **Constructive**

12. How much does the enemy's mission affect your scenario selection?

Value Value

Virtual **Constructive**

13. How much does weather (fog, rain, or haze) affect your scenario selection?

Value Value

Virtual **Constructive**

14. How much does previous use of a scenario affect your scenario selection?

Value Value

Virtual **Constructive**

15. How does the level of difficulty of the exercise affect your scenario selection?

Value Value

Virtual **Constructive**

16. How much does unit past performance assessment (T's, P's, and U's) affect you scenario selection?

Value △ **Virtual** Value ☐ **Constructive**

Very Small Chance 0-20%	Small Chance 21-40%	Could Effect 41-60%	High Chance 61-80%	Very High Chance 81-100%

17. How much do light conditions (daylight, night, % illumination, etc.) affect your scenario selection?

Value △ **Virtual** Value ☐ **Constructive**

18. How much does the capability to support observation devices (FLIR, Thermal, NVG, Optic, etc.) and their degradation affect your scenario selection?

Value △ **Virtual** Value ☐ **Constructive**

19. How much does the amount of exercise preparation required (placement of forces on the battle field, coordination of simulation facility use, and other administrative tasks associated with the training) affect your scenario selection?

Value △ **Virtual** Value ☐ **Constructive**

21. How much does the amount of mission planning required (troop leading procedures, course of action development, OPORD preparation) affect your scenario selection?

Value △ **Virtual** Value ☐ **Constructive**

Very Small Chance	Small Chance	Could Effect	High Chance	Very High Chance
0-20%	21-40%	41-60%	61-80%	81-100%

22. Please list below any other factors that affect your scenario selection?

FACTOR:____

Value

Virtual

Value

Constructive

FACTOR:____

Value

Virtual

Value

Constructive

FACTOR:_______________

Value

Virtual

Value

Constructive

Additional Comments:

Appendix F

Tabulated Pilot Data

Virtual Responses

Questionnaire	Terrain	Task	Simulator	F Comp	E Comp	Power Ratio	Enemy Task Org	E Equip	F Equip	Adjacent Unit	E Train Level	E Mission	Weather	Previous Use	Difficulty	Assessment	Light Data	Observation Devices	Exercise Prep	Mission Planning
1	70	60	65	55	40	65	80	65	80	60	55	75	70	80	65	65	65	65	75	80
2	75	57	90	40	20	25	20	90	95	95	85	65	100	90	100	75	65	95	10	5
3	100	100	100	100	100	100	100	100	100	50	100	100	100	100	100	100	0	50	100	100
4	55	0	70	80	90	90	50	80	100	80	85	100	100	70	100	100	99	100	100	100
5	80	70	90	10	90	40	0	80	20	15	15	30	70	70	25	30	75	30	20	70
6	100	80	90	90	100	100	80	20	60	40	100	20	100	80	100	90	100	90	80	20
7	80	41	100	50	60	81	40	40	90	70	80	80	90	50	90	50	70	50	60	100
8	30	60	90	10	40	25	20	16	25	50	40	45	25	25	40	50	65	40	70	50
9	80	100	80	60	60	60	50	60	60	60	70	80	90	60	70	70	90	50	45	45
10	45	55	30	34	65	70	71	72	60	59	70	74	76	79	80	69	80	84	86	90
11	75	30	56	40	35	30	24	30	60	50	60	40	10	50	60	40	60	50	30	80
12	81	41	21	41	100	80	50	41	100	100	61	0	75	0	75	80	61	61	61	61
13	25	80	90	90	90	90	90	50	40	45	45	50	90	90	90	90	80	80	90	90
14	95	15	10	92	81	87	15	97	92	90	87	8	90	90	80	20	90	70	2	5
15	85	50	60	70	70	90	50	70	50	50	70	55	90	75	60	45	71	50	20	40
16	80	50	100	100	100	50	50	70	70	50	20	50	50	100	100	70	0	100	50	50
17	80	60	30	80	80	60	60	60	60	70	50	80	80	80	60	70	80	80	50	60
18	90	40	90	10	90	70	80	90	50	25	90	70	90	70	80	25	90	80	80	90
19	81	80	61	81	65	60	81	80	80	60	40	40	15	81	61	60	60	80	40	40
20	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
21	80	20	60	25	27	100	80	100	80	85	50	41	85	85	70	25	20	38	75	75
22	80	20	50	30	40	20	10	30	70	40	55	30	90	50	50	30	50	50	20	90
23	80	60	90	85	20	45	40	20	80	95	25	60	75	20	80	100	10	100	5	60
24	80	20	40	90	10	50	60	20	80	30	20	60	20	100	25	10	30	40	50	60
25	70	81	61	45	90	100	45	100	100	40	80	100	100	100	45	65	80	40	60	40
26	80	70	80	64	60	70	20	30	90	60	70	80	40	70	20	60	60	70	20	90
27	80	25	11	75	10	5	10	50	50	40	40	10	50	60	60	40	20	90	15	20
28	85	50	60	70	70	90	50	70	50	50	70	55	90	75	60	45	71	50	20	40
29	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
30	90	40	90	10	90	70	80	90	50	25	90	70	90	70	80	25	90	80	80	90

Constructive Responses

Questionnaire	Terrain	Task	Simulator	F Comp	E Comp	Power Ratio	Enemy Task Org	E Equip	F Equip	Adacent Unit	E Train Level	E Mission	Weather	Previous Use	Difficulty	Assesment	Light Data	Observation Devices	Exercise Prep	Mission Planning
1	20	75	89	25	90	95	90	50	50	60	60	90	50	40	40	40	60	80	10	85
2	20	30	20	36	40	30	80	70	10	40	30	20	60	30	80	40	40	30	80	10
3	60	90	25	40	100	65	80	80	80	60	100	90	80	100	50	70	90	50	60	45
4	60	60	80	10	50	50	30	90	40	70	50	30	80	10	35	20	80	60	50	40
5	20	40	10	15	80	55	60	80	20	5	75	40	25	80	20	0	90	0	95	40
6	20	80	50	70	60	80	90	70	30	60	45	70	10	50	50	70	50	50	80	10
7	60	45	41	30	41	80	80	100	85	85	50	45	85	85	75	30	30	50	75	80
8	20	70	45	60	30	80	45	70	40	40	80	60	30	85	85	85	40	35	65	45
9	60	60	65	81	65	60	81	80	60	55	55	80	10	81	61	40	65	80	60	65
10	50	50	50	40	10	0	50	40	40	0	10	50	30	75	30	0	0	70	10	10
11	40	60	70	60	60	80	60	70	70	60	50	75	60	80	60	50	60	60	50	70
12	79	50	0	0	0	50	50	30	70	50	80	50	50	0	0	30	100	0	50	50
13	15	50	40	30	30	10	50	30	50	50	30	45	10	25	60	55	25	50	70	60
14	5	85	90	8	19	13	85	3	8	10	13	92	10	10	30	80	10	30	98	98
15	90	80	60	90	90	90	50	90	80	45	80	90	55	90	90	90	45	40	90	90
16	81	0	0	0	100	80	0	41	100	100	61	0	75	0	75	80	61	61	61	61
17	25	70	50	60	65	70	80	70	40	50	40	60	90	50	40	60	40	50	70	20
18	50	40	29	35	70	74	72	69	80	61	70	61	62	69	70	72	72	68	68	59
19	60	50	50	80	80	80	60	80	80	80	80	80	80	60	70	70	85	85	85	85
20	55	30	20	10	75	60	60	75	10	20	60	30	60	60	50	65	70	15	50	40
21	60	60	0	50	40	20	60	60	10	30	20	30	10	50	10	50	30	50	40	0
22	100	80	80	90	100	100	80	10	40	40	100	20	100	80	100	90	90	90	80	20
23	40	90	50	40	50	50	0	20	35	40	55	70	25	25	30	0	15	10	15	85
24	75	0	10	80	90	90	50	95	100	90	90	100	100	75	100	100	99	100	100	100
25	50	50	100	50	50	100	50	100	50	25	50	100	50	50	100	50	0	0	50	50
26	25	45	10	60	80	75	80	10	5	5	15	25	0	10	0	25	25	5	90	95
27	75	40	60	65	60	75	60	75	85	65	60	50	70	65	60	40	50	60	40	80
28	20	40	10	15	80	55	60	80	20	5	75	40	25	80	20	0	90	0	95	40
29	20	80	50	70	60	80	90	70	30	60	45	70	10	50	50	70	50	50	80	10
30	55	30	20	10	75	60	60	75	10	20	60	30	60	60	50	65	70	15	50	40

Appendix G

Pilot Mean Data and ANOVA

One-Way Analysis of Variance

All Pilot Responses

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	81212	2082	2.97	0.000
Error	1160	812717	701		
Total	1199	893929			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	---------+---------+---------+-------
Terrain	30	75.73	17.18	(-----*------)
Task	30	53.17	25.08	(-----*------)
Simtor	30	66.83	26.56	(------*-----)
FComp	30	58.90	28.59	(-----*------)
EComp	30	64.43	28.54	(-----*-----)
PowRat	30	65.43	26.33	(------*-----)
ETskOrg	30	51.53	27.20	(-----*------)
EEquip	30	62.03	26.92	(-----*------)
FEquip	30	69.40	21.91	(-----*------)
AdUnit	30	57.47	21.96	(-----*------)
ETrnLev	30	62.10	23.83	(-----*------)
EMision	30	56.93	26.78	(-----*-----)
Weather	30	73.03	26.96	(------*-----)
PrevUse	30	70.33	23.78	(-----*-----)
Diff	30	68.87	22.64	(-----*-----)
Assment	30	57.97	25.43	(------*-----)
LtData	30	62.40	28.10	(------*-----)
ObDev	30	66.77	20.96	(------*-----)
ExPrep	30	51.80	29.62	(------*-----)
MnPlan	30	62.70	27.91	(------*-----)
CTern	30	47.00	25.28	(-----*------)
CTask	30	54.33	23.44	(-----*------)
CSimlatr	30	42.47	29.02	(-----*------)
CFComp	30	43.67	27.76	(-----*-----)
CEComp	30	61.33	26.71	(-----*-----)
CPowRat	30	63.57	26.64	(-----*------)
CETaskOg	30	61.43	22.87	(-----*-----)
CEEquip	30	62.77	27.46	(-----*-----)
CFEquip	30	47.60	29.53	(------*-----)
CAdUnit	30	46.03	26.55	(------*-----)
CETranLv	30	56.30	24.41	(------*-----)
CEMssion	30	56.43	26.94	(------*-----)
CWeather	30	48.73	30.43	(-----*------)
CPrevUse	30	54.17	28.93	(-----*-----)
CDifclty	30	53.03	28.43	(-----*------)
CAssmnt	30	51.23	28.81	(-----*-----)
CLtData	30	54.40	29.29	(-----*------)
CObsDev	30	44.80	29.16	(-----*-----)
CExPrep	30	63.90	24.92	(------*-----)
CMsPlan	30	52.77	29.86	(-----*------)
				---------+---------+---------+-------
Pooled StDev =	26.47			45 60 75

Appendix H

Single Environment Calculations (z test)

z-Test: Two Sample for Means		
	Combat Power Ratio	*Observation Devices*
Mean	63.56666667	44.8
Known Variance	709.42	850.3
Observations	30	30
Hypothesized Mean Difference	0	
z	2.602702007	
P(Z<=z) one-tail	0.00462465	
z Critical one-tail	1.644853	
P(Z<=z) two-tail	0.002312325	
z Critical two-tail	1.959961082	
z > z critical		
So reject the null hypothesis: the means are not equal.		

Observation Devices

80
30
50
60
0
50
50
35
80
70
60
0
50
30
40
61
50
68
85
15
50
90
10
100
0
5
60
0
50
15

Chi-Squared Test

Critical value for 6-1-2=3 df and alpha = 5% is 7.815

Conclusion: Accept Ho (data is normal)

	Bin	*Frequency*	Expected Frequency	Chi-Square terms
0.00	25.00	8	5.5902	0.4523
25.00	40.00	4	5.5818	0.3603
40.00	53.00	7	5.2829	0.0152
53.00	69.00	5	5.5794	0.0317
69.00	100.00	6	5.2235	5.2235
100.00	More	0		6.0830

Observation Devices	
Mean	44.8
Standard Error	5.323856523
Median	50
Mode	50
Standard Deviation	29.1599631
Sample Variance	850.3034483
Kurtosis	-0.882601457
Skewness	-0.101795785
Range	100
Minimum	0
Maximum	100
Sum	1344
Count	30
Confidence Level(95.0%)	10.88851511

Power Ratio
95
30
65
50
55
80
80
80
60
0
80
50
10
13
90
80
70
74
80
60
20
100
50
90
100
75
75
55
80
60

Chi-Squared Test
Critical value for 6-1-2=3 df and alpha = 5% is 7.815
Conclusion: Accept Ho (data is normal)

	Bin	*Frequency*	Expected Frequency	Chi-Square terms
0.00	40.00	5	5.3889	0.0281
40.00	55.00	5	5.5709	0.0585
55.00	67.00	4	5.3215	0.3282
67.00	81.00	11	5.7693	4.7424
81.00	100.00	5	5.1219	0.0029
100.00	More	0		5.1600

Power Ratio	
Mean	63.56667
Standard Error	4.862874
Median	72
Mode	#NUM!
Standard Deviation	26.63506
Sample Variance	709.4264
Kurtosis	0.212669
Skewness	-0.917163
Range	100
Minimum	0
Maximum	100
Sum	1907
Count	30
Confidence Level(95.0%)	9.9457

Appendix I

ANOVA for Armor (Pilot)

One-Way Analysis of Variance

Armor

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	22761	584	1.04	0.426
Error	120	67482	562		
Total	159	90243			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	--------+---------+---------+--------
Terrain	4	67.50	25.00	(-------*------)
Task	4	55.25	34.01	(------*-------)
Simtor	4	80.00	21.60	(-------*------)
FComp	4	37.50	22.17	(-------*------)
EComp	4	50.00	11.55	(-------*------)
PowRat	4	46.50	29.08	(-------*------)
ETskOrg	4	30.00	18.26	(-------*-------)
EEquip	4	36.50	18.50	(-------*-------)
FEquip	4	61.25	27.20	(------*-------)
AdUnit	4	55.00	12.91	(------*-------)
ETrnLev	4	61.25	17.50	(------*-------)
EMision	4	58.75	25.29	(-------*------)
Weather	4	73.75	32.50	(-------*------)
PrevUse	4	46.25	14.93	(------*-------)
Diff	4	62.50	22.17	(-------*-------)
Assment	4	50.00	16.33	(-------*------)
LtData	4	68.75	16.52	(-------*-------)
ObDev	4	47.50	5.00	(-------*-------)
ExPrep	4	48.75	21.75	(-------*-------)
MnPlan	4	71.25	27.80	(-------*-------)
CTern	4	60.00	32.66	(-------*-------)
CTask	4	63.75	14.93	(-------*-------)
CSimlatr	4	57.75	18.17	(-------*-------)
CFComp	4	65.25	26.65	(-------*-------)
CEComp	4	59.00	30.99	(-------*------)
CPowRat	4	80.00	16.33	(-------*------)
CETaskOg	4	71.50	17.67	(-------*-------)
CEEquip	4	65.00	38.73	(-------*------)
CFEquip	4	56.25	21.36	(-------*-------)
CAdUnit	4	55.00	21.21	(------*-------)
CETranLv	4	71.25	23.23	(-------*-------)
CEMssion	4	51.25	25.29	(-------*-------)
CWeather	4	56.25	43.08	(-------*-------)
CPrevUse	4	82.75	2.63	(-------*------)
CDifclty	4	80.25	16.44	(-------*-------)
CAssmnt	4	61.25	30.65	(------*-------)
CLtData	4	56.25	26.89	(-------*-------)
CObsDev	4	63.75	25.62	(-------*-------)
CExPrep	4	70.00	9.13	(------*-------)
CMsPlan	4	52.50	25.98	(-------*------)

--------+---------+---------+--------
30 60 90

Pooled StDev = 23.71

Appendix J

ANOVA for Infantry (Pilot)

One-Way Analysis of Variance
Infantry
Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	40833	1047	1.36	0.104
Error	120	92174	768		
Total	159	133007			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	--------+---------+---------+--------
Terrain	4	81.25	13.15	(--------*--------)
Task	4	59.25	32.69	(--------*--------)
Simtor	4	78.75	19.31	(--------*--------)
FComp	4	55.00	32.40	(--------*--------)
EComp	4	46.75	36.45	(---------*--------)
PowRat	4	72.50	35.71	(--------*--------)
ETskOrg	4	70.00	34.64	(--------*--------)
EEquip	4	88.75	16.52	(---------*--------)
FEquip	4	88.75	10.31	(---------*--------)
AdUnit	4	72.50	21.02	(--------*--------)
ETrnLev	4	72.50	23.98	(--------*--------)
EMision	4	70.25	24.43	(--------*---------)
Weather	4	88.75	14.36	(---------*--------)
PrevUse	4	88.75	8.54	(---------*--------)
Diff	4	83.75	18.87	(--------*--------)
Assment	4	66.25	31.19	(--------*--------)
LtData	4	37.50	32.79	(---------*--------)
ObDev	4	62.00	24.62	(--------*--------)
ExPrep	4	65.00	38.51	(--------*--------)
MnPlan	4	65.00	41.43	(--------*--------)
CTern	4	40.00	23.09	(--------*--------)
CTask	4	63.75	25.62	(--------*--------)
CSimlatr	4	33.50	38.54	(--------*--------)
CFComp	4	37.75	10.34	(---------*--------)
CEComp	4	67.50	32.02	(---------*--------)
CPowRat	4	52.50	34.28	(---------*--------)
CETaskOg	4	77.50	12.58	(--------*--------)
CEEquip	4	65.00	12.91	(--------*--------)
CFEquip	4	37.50	34.03	(---------*--------)
CAdUnit	4	47.50	15.00	(--------*--------)
CETranLv	4	52.50	35.94	(---------*--------)
CEMssion	4	57.50	37.75	(--------*--------)
CWeather	4	50.00	29.44	(--------*--------)
CPrevUse	4	55.00	31.09	(--------*--------)
CDifclty	4	45.00	28.87	(--------*--------)
CAssmnt	4	50.00	14.14	(--------*--------)
CLtData	4	55.00	26.46	(--------*--------)
CObsDev	4	52.50	20.62	(---------*--------)
CExPrep	4	47.50	29.86	(--------*--------)
CMsPlan	4	35.00	38.51	(--------*--------)
				---------+---------+---------+--------
Pooled StDev =	27.71			30 60 90

Appendix K

Chi-square test of Frequency Independence For Terrain and Task (Pilot)

Chi-Square Test
Terrain

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	1	2	1	9	17	30
	5.00	3.00	6.00	6.00	10.00	
2	9	4	11	3	3	30
	5.00	3.00	6.00	6.00	10.00	
Total	10	6	12	12	20	60

ChiSq = 3.200 + 0.333 + 4.167 + 1.500 + 4.900 +
3.200 + 0.333 + 4.167 + 1.500 + 4.900 = 28.200
df = 4, p = 0.000
2 cells with expected counts less than 5.0

Chi-Square Test
Task

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	3	3	12	9	3	30
	2.50	6.00	10.50	8.50	2.50	
2	2	9	9	8	2	30
	2.50	6.00	10.50	8.50	2.50	
Total	5	12	21	17	5	60

ChiSq = 0.100 + 1.500 + 0.214 + 0.029 + 0.100 +
0.100 + 1.500 + 0.214 + 0.029 + 0.100 = 3.887
df = 4, p = 0.422
4 cells with expected counts less than 5.0

Appendix L

Tabulated Data for the Target Population

Constructive Responses

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Devices	C Exercise Prep	C Mission Planning
10	AD	MAJ	90	70	80	80	90	90	90	90	90	90	90	90	90	90	80	80	80	80	50	50
49	AD	MAJ	80	60	50	60	60	50	25	25	75	20	20	20	20	75	85	85	25	20	10	10
56	AD	LTC	60	80	30	80	60	80	80	80	80	60	80	90	70	90	80	100	60	90	90	90
61	AD	LTC	95	20	90	50	50	50	50	50	50	50	50	50	20	95	85	98	20	20	80	95
1	AR	COL	50	50	90	70	90	70	70	50	50	50	50	70	70	70	70	90	70	50	50	30
31	AR	CPT	50	50	100	100	50	75	25	75	50	50	50	75	25	50	100	75	0	25	75	50
36	AR	MAJ	80	80	90	90	80	90	75	80	100	80	60	90	81	90	90	90	60	60	90	90
50	AR	MAJ	40	80	80	61	61	61	61	50	50	50	21	41	40	80	70	70	40	40	70	80
52	AR	COL	30	90	80	50	40	50	50	50	50	40	50	40	40	75	50	90	50	50	90	70
57	AR	MAJ	70	10	10	10	0	60	60	0	0	0	0	20	0	80	10	60	20	80	80	20
60	AR	COL	10	90	30	30	30	40	40	40	40	40	30	30	0	100	20	100	0	0	20	0
62	AR	LTC	75	70	90	50	30	10	10	10	90	90	30	30	10	30	90	50	60	60	90	90
22	AV	CPT	95	95	90	100	85	100	0	0	80	80	50	100	50	100	50	70	50	0	100	100
37	AV	MAJ	0	50	90	90	90	90	90	90	90	90	50	80	90	50	50	90	90	90	90	80
38	AV	CPT	75	50	50	50	80	70	50	40	50	50	50	30	30	90	50	30	30	50	70	20
45	AV	MAJ	10	40	20	20	60	80	80	60	60	60	100	100	100	100	100	80	10	20	100	100
46	AV		70	50	70	50	70	70	70	50	60	60	50	50	70	70	80	80	70	75	80	90
51	AV	MAJ	60	70	70	40	60	60	60	60	30	20	20	70	40	70	20	60	10	10	70	50
43	CM	NA	60	40	80	50	80	80	80	60	60	60	60	80	60	60	60	80	60	60	50	50
19	EN	MAJ	50	75	80	75	75	50	50	30	30	30	50	75	50	50	50	90	50	30	90	50
2	FA	MAJ	75	100	90	75	90	81	81	81	81	81	90	95	90	75	90	98	85	85	92	85
3	FA	MAJ	50	50		80	100	60	90	60	30	30	80	90	30	70	80	80	60	60	70	60
4	FA	MAJ	75	95	20	100	80	90	0	100	100	90	65	75	0	80	100	90	0	70	100	100
5	FA	LTC	80	80	80	40	60	80	80	80	60	40	80	80	80	40	80	100	80	100	80	80
12	FA	LTC	90	100	25	100	90	50	50	70	70	60	25	25	30	25	90	90	50	50	20	90
40	FA	MAJ	0	100	50	100	100	50	80	80	80	50	80	100	100	100	80	100	0	0	80	100
58	FA	MAJ	100	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Constructive Responses Continued

6	IN	COL(P)	90	100	40	100	100	75	85	85	100	85	40	90	55	20	85	95	85	100	65	65
11	IN	MAJ(P)	95	80	95	95	95	95	95	95	95	95	80	85	60	70	21	50	75	50	95	95
20	IN	MAJ	75	50	25	50	0	0	0	0	25	0	0	0	0	25	50	100	50	50	0	25
27	IN	MAJ	100	80	80	80	80	85	85	85	80	80	21	80	50	90	25	50	80	25	25	25
32	IN	MAJ	70	60	100	100	40	70	25	60	50	50	50	60	50	50	100	75	0	30	70	50
33	IN	CPT	80	80	80	80	80	80	80	80	80	80	80	80	80	80	100	80	100	80	80	80
34	IN	CPT	40	80	60	40	80	80	80	50	40	40	90	90	50	50	50	20	20	40	40	40
35	IN	MAJ	90	90		90	90	90	90	90	90	70	90	90	80	90		90	80	80	80	80
41	IN	MAJ	90	60	50	90	100	50	0	75	75	0	0	70	30	60	65	80	30	20	0	0
44	IN	CPT	40	60	30	20	30	40	60	30	50	10	70	70	60	70	50	70	60	70	80	80
47	IN	LTC(P)	70	70	70	10	10	50	10	10	50	50	10	10	50	70	70	50	10	10	30	70
48	IN	LTC	70	95	80	75	90	90	85	80	85	50	60	80	50	50	50	85	70	40	75	99
53	IN	MAJ	50	80	60	60	60	50	60	60	60	60	20	60	40	60	60	60	60	40	40	40
54	IN	LTC	85	85	95	95	85	90	90	88	88	60	75	60	50	50	50	30	60	30	50	90
55	IN	LTC	75	50	80	80	5	80	5	5	100	100	5	0	0	80	100	80	0	0	80	80
59	IN	LTC	40	60	20	0	40	60	40	60	40	70	40	60	0	60	50	100	20	0	40	0
24	MI	CPT(P)	100	80	80	80	80	85	90	85	80	80	100	80	85	90	100	25	100	80	25	30
7	MP	LTC	40	50	60	60	10	40	60	40	50	50	10	50	60	60	50	80	60	40	60	60
8	MP	MAJ	5	50	40	10	30	35	10	10	20	20	30	25	5	15	10	90	5	5	45	10
9	MP	MAJ(P)	50	80	75	50	40	10	10	50	50	60	20	40	20	50	70	80	10	10	75	75
21	MP	MAJ	90	90	100	100	85	85	85	50	50	50	75	70	75	50	50	100	85	75	95	100
42	MP	NA	61	80	80	80	81	81	81	81	81	80	80	85	60	80	60	88	50	60	85	45
25	NA	NA	21	22	26	40	40	36	22	22	18	40	21	41	36	40	38	21	21	21	21	21
26	NA	NA	80	90	50	90	90	90	90	90	90	90	90	90	65	90	90		90	90	80	80
28	NA	NA	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
39	NA	NA	85	80	75	80	85	85	90	95	95	95	70	80	75	60	30	95	15	20	50	35
14	OD	MAJ	20	40	20	30	30	15	10	40	70	50	0	10	10	80	15	90	15	10	5	10
15	OD	LTC	75	25	80	20	50	41	41	41	75	25	25	75	80	100	90	90	61	25	75	75
16	OD	LTC	41	45	85	50	100	80	80	85	80	50	55	100	60	55	90	75	65	85	90	81
13	QM	MAJ	75	60	90	100	90	20	20	20	90	80	20	50	50	80	80	90	80	50	90	90
17	QM	MAJ	75	30	39	64	89	51	79	92	80	83	95	96	99	81	25	58	68	54	97	9
23	QM	MAJ	80	80	80	80	90	85	85	80	80	80	80	85	90	95	100	80	80	80	80	80
18	SC	MAJ	80	90	90	0	0	0	0	0	0	0	0	50	0	100	70	80	0	0	100	100
29	SC	LTC	70	70	80	90	80	80	90	60	80	80	60	75	40	70	50	70	50	60	40	40
30	TC	CPT	80	80	80	80	80	80	75	80	100	50	80	100	100	100	100	100	100	100	100	100

Virtual Responses

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Devices	V Exercise Prep	V Mission Planning
10	AD	MAJ	20	30	20	20	40	40	30	40	40	40	40	40	40	40	20	20	40	40	40	50
49	AD	MAJ	80	60	50	75	75	50	25	25	75	20	20	20	20	75	85	85	25	20	10	10
56	AD	LTC	80	80	30	80	60	80	80	80	90	60	90	90	70	90	80	100	60	90	90	90
61	AD	LTC	95	50	95	80	80	80	80	80	80	80	80	80	80	85	90	98	90	95	60	95
1	AR	COL	70	50	90	90	90	90	70	70	50	50	50	70	90	70	70	90	90	90	50	30
31	AR	CPT																				
36	AR	MAJ	90	81	90	90	80	80	75	80	100	80	60	80	81	90	90	90	60	90	90	90
50	AR	MAJ	70	80	80	61	61	61	61	61	61	61	40	21	60	80	80	80	80	80	80	80
52	AR	COL	70	90	80	50	40	50	50	50	50	40	50	60	70	75	50	90	50	50	80	70
57	AR	MAJ	80	20	60	10	0	40	40	0	0	0	0	20	45	80	85	85	85	60	20	60
60	AR	COL	70	90	70	70	70	60	100	60	60	60	70	70	50	100	60	100	30	50	20	20
62	AR	LTC	90	90	90	10	30	10	10	10	75	75	30	30	10	30	90	90	60	60	90	90
22	AV	CPT	90	95	90	100	90	90	0	0	100	100	100	100	100	100	50	70	100	100	100	100
37	AV	MAJ	90	90	90	90	90	90	90	90	90	90	50	80	90	50	50	90	90	90	90	80
38	AV	CPT	50	50	50	70	70	30	30	70	70	50	70	40	80	90	50	30	50	70	30	20
45	AV	MAJ	10	40	20	20	60	80	80	100	100	80	100	100	100	100	100	100	20	100	80	100
46	AV		90	80	90	25	75	50	50	50	90	90	50	50	90	90	80	50	70	95	60	60
51	AV	MAJ	30	50	70	20	60	60	60	60	30	20	20	20	60	30	20	20	80	80	20	30
43	CM	NA	80	80	60	60	80	80	60	80	60	60	80	80	60	40	40	80	60	60	40	50
19	EN	MAJ	75	75	80	90	75	50	50	50	75	75	75	75	75	50	50	90	75	75	80	50
2	FA	MAJ	90	100	90	81	90	81	81	81	81	81	90	95	90	75	90	98	85	85	92	85
3	FA	MAJ	80	80		80	100	60	90	60	30	30	80	90	90	70	80	80	80	80	70	60
4	FA	MAJ	85	60	10	50	20	50	0	70	75	75	50	75	0	80	90	60	0	75	100	100
5	FA	LTC	80	80	80	40	60	80	80	80	60	40	80	80	80	40	80	100	80	100	80	80
12	FA	LTC	90	100	25	100	90	50	50	70	70	60	25	25	30	25	90	90	50	50	20	90
40	FA	MAJ	0	100	0	0	30	50	50	80	80	50	80	0	100	100	80	100	100	100	20	20
58	FA	MAJ	100	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Virtual Responses Continued

6	IN	COL(P)																				
11	IN	MAJ(P)	95	21	21	21	50	50	50	50	50	50	50	50	50	60	21	5	50	21	25	20
20	IN	MAJ																				
27	IN	MAJ																				
32	IN	MAJ																				
33	IN	CPT																				
34	IN	CPT	40	80	60	40	80	80	80	50	40	40	90	90	50	50	50	20	20	40	40	40
35	IN	MAJ																				
41	IN	MAJ	90	85	90	90	100	40	0	80	80	0	0	70	0	90	100	90	90	100	0	0
44	IN	CPT	70	90	80	80	50	60	60	20	50	10	70	70	80	80	95	100	60	70	20	50
47	IN	LTC(P)	50	30	70	10	10	50	10	10	30	30	10	10	50	20	20	50	90	10	30	70
48	IN	LTC	90	60	99	80	100	100	100	90	70	80	90	100	50	70	70	85	70	45	33	89
53	IN	MAJ	50	80	60	40	40	50	10	10	60	60	20	20	60	40	40	40	60	60	60	40
54	IN	LTC	85	65	95	95	65	50	50	70	70	30	50	50	50	50	50	20	50	80	40	40
55	IN	LTC	85	90	80	30	5	80	5	5	100	100	5	0	0	80	100	100	20	80	80	80
59	IN	LTC	60	60	20	0	40	30	60	60	40	70	20	80	20	40	40	100	20	20	30	0
24	MI	CPT(P)																				
7	MP	LTC	10	10	20	40	60	60	40	60	50	50	10	50	60	60	50	80	60	40	70	60
8	MP	MAJ	5	50	40	10	30	35	10	10	20	20	30	25	5	15	10	90	5	5	45	10
9	MP	MAJ(P)	50	60	50	50	30	10	10	50	50	60	20	40	20	50	60	80	10	10	75	75
21	MP	MAJ																				
42	MP	NA	50	61	50	50	81	81	81	81	81	80	80	85	60	80	60	88	50	60	85	45
25	NA	NA	22	21	24	36	31	30	21	22	20	26	21	41	36	40	38	21	21	21	21	21
26	NA	NA	90	90	90	90	90	90	90	90	60	50	90	90	90	50	90		90	90	80	80
28	NA	NA	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
39	NA	NA	45	80	40	50	65	65	70	75	75	70	60	80	60	60	30	95	15	20	50	35
14	OD	MAJ	20	40	20	25	25	15	10	30	60	40	0	10	10	10	10	80	10	10	5	10
15	OD	LTC	60	25	80	20	50	60	41	41	75	25	25	75	50	100	60	90	61	21	75	75
16	OD	LTC	40	80	65	50	100	80	90	90	90	50	65	100	65	65	80	80	45	90	90	90
13	QM	MAJ	75	60	90	50	90	20	20	20	90	80	20	50	50	50	50	90	80	50	90	50
17	QM	MAJ	70	20	46	51	80	50	81	88	75	78	90	91	98	80	23	50	71	52	94	10
23	QM	MAJ																				
18	SC	MAJ	80	90	90	20	0	0	0	0	0	0	0	50	70	100	70	80	0	0	100	100
29	SC	LTC																				
30	TC	CPT																				

Air Defence

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Devices	C Exercise Prep	C Mission Planning
10	AD	MAJ	90	70	80	80	90	90	90	90	90	90	90	90	90	90	80	80	80	80	50	50
49	AD	MAJ	80	60	50	60	60	50	25	25	75	20	20	20	20	75	85	85	25	20	10	10
56	AD	LTC	60	80	30	80	60	80	80	80	80	60	80	90	70	90	80	100	60	90	90	90
61	AD	LTC	95	20	90	50	50	50	50	50	50	50	50	50	20	95	85	98	20	20	80	95

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Devices	V Exercise Prep	V Mission Planning
10	AD	MAJ	20	30	20	20	40	40	30	40	40	40	40	40	40	40	20	20	40	40	40	50
49	AD	MAJ	80	60	50	75	75	50	25	25	75	20	20	20	20	75	85	85	25	20	10	10
56	AD	LTC	80	80	30	80	60	80	80	80	90	60	90	90	70	90	80	100	60	90	90	90
61	AD	LTC	95	50	95	80	80	80	80	80	80	80	80	80	80	85	90	98	90	95	60	95

Armor

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Devices	C Exercise Prep	C Mission Planning
1	AR	COL	50	50	90	70	90	70	70	50	50	50	50	70	70	70	70	90	70	50	50	30
31	AR	CPT	50	50	100	100	50	75	25	75	50	50	50	75	25	50	100	75	0	25	75	50
36	AR	MAJ	80	80	90	90	80	90	75	80	100	80	60	90	81	90	90	90	60	60	90	90
50	AR	MAJ	40	80	80	61	61	61	61	50	50	50	21	41	40	80	70	70	40	40	70	80
52	AR	COL	30	90	80	50	40	50	50	50	50	40	50	40	40	75	50	90	50	50	90	70
57	AR	MAJ	70	10	10	10	0	60	60	0	0	0	0	20	0	80	10	60	20	80	80	20
60	AR	COL	10	90	30	30	30	40	40	40	40	40	30	30	0	100	20	100	0	0	20	0
62	AR	LTC	75	70	90	50	30	10	10	10	90	90	30	30	10	30	90	50	60	60	90	90

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Devices	V Exercise Prep	V Mission Planning
1	AR	COL	70	50	90	90	90	90	70	70	50	50	50	70	90	70	70	90	90	90	50	30
31	AR	CPT	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
36	AR	MAJ	90	81	90	90	80	80	75	80	100	80	60	80	81	90	90	90	60	90	90	90
50	AR	MAJ	70	80	80	61	61	61	61	61	61	61	40	21	60	80	80	80	80	80	80	80
52	AR	COL	70	90	80	50	40	50	50	50	50	40	50	60	70	75	50	90	50	50	80	70
57	AR	MAJ	80	20	60	10	0	40	40	0	0	0	0	20	45	80	85	85	85	60	20	60
60	AR	COL	70	90	70	70	70	60	100	60	60	60	70	70	50	100	60	100	30	50	20	20
62	AR	LTC	90	90	90	10	30	10	10	10	75	75	30	30	10	30	90	90	60	60	90	90

Aviation

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
22	AV	CPT	95	95	90	100	85	100	0	0	80	80	50	100	50	100	50	70	50	0	100	100
37	AV	MAJ	0	50	90	90	90	90	90	90	90	90	50	80	90	50	50	90	90	90	90	80
38	AV	CPT	75	50	50	50	80	70	50	40	50	50	50	30	30	90	50	30	30	50	70	20
45	AV	MAJ	10	40	20	20	60	80	80	60	60	60	100	100	100	100	100	80	10	20	100	100
46	AV		70	50	70	50	70	70	70	50	60	60	50	50	70	70	80	80	70	75	80	90
51	AV	MAJ	60	70	70	40	60	60	60	60	30	20	20	70	40	70	20	60	10	10	70	50

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
22	AV	CPT	90	95	90	100	90	90	0	0	100	100	100	100	100	100	50	70	100	100	100	100
37	AV	MAJ	90	90	90	90	90	90	90	90	90	90	50	80	90	50	50	90	90	90	90	80
38	AV	CPT	50	50	50	70	70	30	30	70	70	50	70	40	80	90	50	30	50	70	30	20
45	AV	MAJ	10	40	20	20	60	80	80	100	100	80	100	100	100	100	100	100	20	100	80	100
46	AV		90	80	90	25	75	50	50	50	90	90	50	50	90	90	80	50	70	95	60	60
51	AV	MAJ	30	50	70	20	60	60	60	60	30	20	20	20	60	30	20	20	80	80	20	30

Field Artillery

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
2	FA	MAJ	75	100	90	75	90	81	81	81	81	81	90	95	90	75	90	98	85	85	92	85
3	FA	MAJ	50	50	*	80	100	60	90	60	30	30	80	90	30	70	80	80	60	60	70	60
4	FA	MAJ	75	95	20	100	80	90	0	100	100	90	65	75	0	80	100	90	0	70	100	100
5	FA	LTC	80	80	80	40	60	80	80	80	60	40	80	80	80	40	80	100	80	100	80	80
12	FA	LTC	90	100	25	100	90	50	50	70	70	60	25	25	30	25	90	90	50	50	20	90
40	FA	MAJ	0	100	50	100	100	50	80	80	80	50	80	100	100	100	80	100	0	0	80	100
58	FA	MAJ	100	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
2	FA	MAJ	90	100	90	81	90	81	81	81	81	81	90	95	90	75	90	98	85	85	92	85
3	FA	MAJ	80	80	*	80	100	60	90	60	30	30	80	90	90	70	80	80	80	80	70	60
4	FA	MAJ	85	60	10	50	20	50	0	70	75	75	50	75	0	80	90	60	0	75	100	100
5	FA	LTC	80	80	80	40	60	80	80	80	60	40	80	80	80	40	80	100	80	100	80	80
12	FA	LTC	90	100	25	100	90	50	50	70	70	60	25	25	30	25	90	90	50	50	20	90
40	FA	MAJ	0	100	0	0	30	50	50	80	80	50	80	0	100	100	80	100	100	100	20	20
58	FA	MAJ	100	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Infantry

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
6	IN	COL(	90	100	40	100	100	75	85	85	100	85	40	90	55	20	85	95	85	100	65	65
11	IN	MAJ(	95	80	95	95	95	95	95	95	95	95	80	85	60	70	21	50	75	50	95	95
20	IN	MAJ	75	50	25	50	0	0	0	0	25	0	0	0	0	25	50	100	50	50	0	25
27	IN	MAJ	100	80	80	80	80	85	85	85	80	80	21	80	50	90	25	50	80	25	25	25
32	IN	MAJ	70	60	100	100	40	70	25	60	50	50	50	60	50	50	100	75	0	30	70	50
33	IN	CPT	80	80	80	80	80	80	80	80	80	80	80	80	80	80	100	80	100	80	80	80
34	IN	CPT	40	80	60	40	80	80	80	50	40	40	90	90	50	50	50	20	20	40	40	40
35	IN	MAJ	90	90	*	90	90	90	90	90	90	70	90	90	80	90	*	90	80	80	80	80
41	IN	MAJ	90	60	50	90	100	50	0	75	75	0	0	70	30	60	65	80	30	20	0	0
44	IN	CPT	40	60	30	20	30	40	60	30	50	10	70	70	60	70	50	70	60	70	80	80
47	IN	LTC(	70	70	70	10	10	50	10	10	50	50	10	10	50	70	70	50	10	10	30	70
48	IN	LTC	70	95	80	75	90	90	85	80	85	50	60	80	50	50	50	85	70	40	75	99
53	IN	MAJ	50	80	60	60	60	50	60	60	60	60	20	60	40	60	60	60	60	40	40	40
54	IN	LTC	85	85	95	95	85	90	90	88	88	60	75	60	50	50	50	30	60	30	50	90
55	IN	LTC	75	50	80	80	5	80	5	5	100	100	5	0	0	80	100	80	0	0	80	80
59	IN	LTC	40	60	20	0	40	60	40	60	40	70	40	60	0	60	50	100	20	0	40	0

Infantry Continued

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
6	IN	COL(	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	IN	MAJ(	95	21	21	21	50	50	50	50	50	50	50	50	50	60	21	5	50	21	25	20
20	IN	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
27	IN	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
32	IN	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
33	IN	CPT	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
34	IN	CPT	40	80	60	40	80	80	80	50	40	40	90	90	50	50	50	20	20	40	40	40
35	IN	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
41	IN	MAJ	90	85	90	90	100	40	0	80	80	0	0	70	0	90	100	90	90	100	0	0
44	IN	CPT	70	90	80	80	50	60	60	20	50	10	70	70	80	80	95	100	60	70	20	50
47	IN	LTC(	50	30	70	10	10	50	10	10	30	30	10	10	50	20	20	50	90	10	30	70
48	IN	LTC	90	60	99	80	100	100	100	90	70	80	90	100	50	70	70	85	70	45	33	89
53	IN	MAJ	50	80	60	40	40	50	10	10	60	60	20	20	60	40	40	40	60	60	60	40
54	IN	LTC	85	65	95	95	65	50	50	70	70	30	50	50	50	50	50	20	50	80	40	40
55	IN	LTC	85	90	80	30	5	80	5	5	100	100	5	0	0	80	100	100	20	80	80	80
59	IN	LTC	60	60	20	0	40	30	60	60	40	70	20	80	20	40	40	100	20	20	30	0

Military Police

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
7	MP	LTC	40	50	60	60	10	40	60	40	50	50	10	50	60	60	50	80	60	40	60	60
8	MP	MAJ	5	50	40	10	30	35	10	10	20	20	30	25	5	15	10	90	5	5	45	10
9	MP	MAJ(	50	80	75	50	40	10	10	50	50	60	20	40	20	50	70	80	10	10	75	75
21	MP	MAJ	90	90	100	100	85	85	85	50	50	50	75	70	75	50	50	100	85	75	95	100
42	MP	NA	61	80	80	80	81	81	81	81	81	80	80	85	60	80	60	88	50	60	85	45

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
7	MP	LTC	10	10	20	40	60	60	40	60	50	50	10	50	60	60	50	80	60	40	70	60
8	MP	MAJ	5	50	40	10	30	35	10	10	20	20	30	25	5	15	10	90	5	5	45	10
9	MP	MAJ(	50	60	50	50	30	10	10	50	50	60	20	40	20	50	60	80	10	10	75	75
21	MP	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
42	MP	NA	50	61	50	50	81	81	81	81	81	80	80	85	60	80	60	88	50	60	85	45

Ordinance

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
14	OD	MAJ	20	40	20	30	30	15	10	40	70	50	0	10	10	80	15	90	15	10	5	10
15	OD	LTC	75	25	80	20	50	41	41	41	75	25	25	75	80	100	90	90	61	25	75	75
16	OD	LTC	41	45	85	50	100	80	80	85	80	50	55	100	60	55	90	75	65	85	90	81

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
14	OD	MAJ	20	40	20	25	25	15	10	30	60	40	0	10	10	10	10	80	10	10	5	10
15	OD	LTC	60	25	80	20	50	60	41	41	75	25	25	75	50	100	60	90	61	21	75	75
16	OD	LTC	40	80	65	50	100	80	90	90	90	50	65	100	65	65	80	80	45	90	90	90

Quartermaster

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
13	QM	MAJ	75	60	90	100	90	20	20	20	90	80	20	50	50	80	80	90	80	50	90	90
17	QM	MAJ	75	30	39	64	89	51	79	92	80	83	95	96	99	81	25	58	68	54	97	9
23	QM	MAJ	80	80	80	80	90	85	85	80	80	80	80	85	90	95	100	80	80	80	80	80

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
13	QM	MAJ	75	60	90	50	90	20	20	20	90	80	20	50	50	50	50	90	80	50	90	50
17	QM	MAJ	70	20	46	51	80	50	81	88	75	78	90	91	98	80	23	50	71	52	94	10
23	QM	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Signal Corps

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
18	SC	MAJ	80	90	90	0	0	0	0	0	0	0	0	50	0	100	70	80	0	0	100	100
29	SC	LTC	70	70	80	90	80	80	90	60	80	80	60	75	40	70	50	70	50	60	40	40

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
18	SC	MAJ	80	90	90	20	0	0	0	0	0	0	0	50	70	100	70	80	0	0	100	100
29	SC	LTC	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Unknown

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
25	NA	NA	21	22	26	40	40	36	22	22	18	40	21	41	36	40	38	21	21	21	21	21
26	NA	NA	80	90	50	90	90	90	90	90	90	90	90	90	65	90	90	*	90	90	80	80
28	NA	NA	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
39	NA	NA	85	80	75	80	85	85	90	95	95	95	70	80	75	60	30	95	15	20	50	35

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
25	NA	NA	22	21	24	36	31	30	21	22	20	26	21	41	36	40	38	21	21	21	21	21
26	NA	NA	90	90	90	90	90	90	90	90	60	50	90	90	90	50	90	*	90	90	80	80
28	NA	NA	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
39	NA	NA	45	80	40	50	65	65	70	75	75	70	60	80	60	60	30	95	15	20	50	35

Ground Maneuver Continued

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
1	AR	COL	70	50	90	90	90	90	70	70	50	50	50	70	90	70	70	90	90	90	50	30
31	AR	CPT	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
36	AR	MAJ	90	81	90	90	80	80	75	80	100	80	60	80	81	90	90	90	60	90	90	90
50	AR	MAJ	70	80	80	61	61	61	61	61	61	61	40	21	60	80	80	80	80	80	80	80
52	AR	COL	70	90	80	50	40	50	50	50	50	40	50	60	70	75	50	90	50	50	80	70
57	AR	MAJ	80	20	60	10	0	40	40	0	0	0	0	20	45	80	85	85	85	60	20	60
60	AR	COL	70	90	70	70	70	60	100	60	60	60	70	70	50	100	60	100	30	50	20	20
62	AR	LTC	90	90	90	10	30	10	10	10	75	75	30	30	10	30	90	90	60	60	90	90
6	IN	COL(	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	IN	MAJ(	95	21	21	21	50	50	50	50	50	50	50	50	50	60	21	5	50	21	25	20
20	IN	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
27	IN	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
32	IN	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
33	IN	CPT	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
34	IN	CPT	40	80	60	40	80	80	80	50	40	40	90	90	50	50	50	20	20	40	40	40
35	IN	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
41	IN	MAJ	90	85	90	90	100	40	0	80	80	0	0	70	0	90	100	90	90	100	0	0
44	IN	CPT	70	90	80	80	50	60	60	20	50	10	70	70	80	80	95	100	60	70	20	50
47	IN	LTC(	50	30	70	10	10	50	10	10	30	30	10	10	50	20	20	50	90	10	30	70
48	IN	LTC	90	60	99	80	100	100	100	90	70	80	90	100	50	70	70	85	70	45	33	89
53	IN	MAJ	50	80	60	40	40	50	10	10	60	60	20	20	60	40	40	40	60	60	60	40
54	IN	LTC	85	65	95	95	65	50	50	70	70	30	50	50	50	50	50	20	50	80	40	40
55	IN	LTC	85	90	80	30	5	80	5	5	100	100	5	0	0	80	100	100	20	80	80	80
59	IN	LTC	60	60	20	0	40	30	60	60	40	70	20	80	20	40	40	100	20	20	30	0

Combat Service and Combat Service Support

Questionnaire	Branch	Rank	C Terrain	C Task	C Simulator	C F Comp	C E Comp	C Power Ratio	C Enemy Task Org	C E Equip	C F Equip	C Adacent Unit	C E Train Level	C E Mission	C Weather	C Previous Use	C Difficulty	C Assesment	C Light Data	C Observation Device	C Exercise Prep	C Mission Planning
10	AD	MAJ	90	70	80	80	90	90	90	90	90	90	90	90	90	90	80	80	80	80	50	50
49	AD	MAJ	80	60	50	60	60	50	25	25	75	20	20	20	20	75	85	85	25	20	10	10
56	AD	LTC	60	80	30	80	60	80	80	80	80	60	80	90	70	90	80	100	60	90	90	90
61	AD	LTC	95	20	90	50	50	50	50	50	50	50	50	50	20	95	85	98	20	20	80	95
43	CM	NA	60	40	80	50	80	80	80	60	60	60	60	80	60	60	60	80	60	60	50	50
19	EN	MAJ	50	75	80	75	75	50	50	30	30	30	50	75	50	50	50	90	50	30	90	50
24	MI	CPT(	100	80	80	80	80	85	90	85	80	80	100	80	85	90	100	25	100	80	25	30
7	MP	LTC	40	50	60	60	10	40	60	40	50	50	10	50	60	60	50	80	60	40	60	60
8	MP	MAJ	5	50	40	10	30	35	10	10	20	20	30	25	5	15	10	90	5	5	45	10
9	MP	MAJ(	50	80	75	50	40	10	10	50	50	60	20	40	20	50	70	80	10	10	75	75
21	MP	MAJ	90	90	100	100	85	85	85	50	50	50	75	70	75	50	50	100	85	75	95	100
42	MP	NA	61	80	80	80	81	81	81	81	81	80	80	85	60	80	60	88	50	60	85	45
14	OD	MAJ	20	40	20	30	30	15	10	40	70	50	0	10	10	80	15	90	15	10	5	10
15	OD	LTC	75	25	80	20	50	41	41	41	75	25	25	75	80	100	90	90	61	25	75	75
16	OD	LTC	41	45	85	50	100	80	80	85	80	50	55	100	60	55	90	75	65	85	90	81
13	QM	MAJ	75	60	90	100	90	20	20	20	90	80	20	50	50	80	80	90	80	50	90	90
17	QM	MAJ	75	30	39	64	89	51	79	92	80	83	95	96	99	81	25	58	68	54	97	9
23	QM	MAJ	80	80	80	80	90	85	85	80	80	80	80	85	90	95	100	80	80	80	80	80
18	SC	MAJ	80	90	90	0	0	0	0	0	0	0	0	50	0	100	70	80	0	0	100	100
29	SC	LTC	70	70	80	90	80	80	90	60	80	80	60	75	40	70	50	70	50	60	40	40
30	TC	CPT	80	80	80	80	80	80	75	80	100	50	80	100	100	100	100	100	100	100	100	100

Combat Service and Combat Service Support Continued

Questionnaire	Branch	Rank	V Terrain	V Task	V Simulator	V F Comp	V E Comp	V Power Ratio	V Enemy Task Org	V E Equip	V F Equip	V Adacent Unit	V E Train Level	V E Mission	V Weather	V Previous Use	V Difficulty	V Assesment	V Light Data	V Observation Device	V Exercise Prep	V Mission Planning
10	AD	MAJ	20	30	20	20	40	40	30	40	40	40	40	40	40	40	20	20	40	40	40	50
49	AD	MAJ	80	60	50	75	75	50	25	25	75	20	20	20	20	75	85	85	25	20	10	10
56	AD	LTC	80	80	30	80	60	80	80	80	90	60	90	90	70	90	80	100	60	90	90	90
61	AD	LTC	95	50	95	80	80	80	80	80	80	80	80	80	80	85	90	98	90	95	60	95
43	CM	NA	80	80	60	60	80	80	60	80	60	60	80	80	60	40	40	80	60	60	40	50
19	EN	MAJ	75	75	80	90	75	50	50	50	75	75	75	75	75	50	50	90	75	75	80	50
24	MI	CPT(	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
7	MP	LTC	10	10	20	40	60	60	40	60	50	50	10	50	60	60	50	80	60	40	70	60
8	MP	MAJ	5	50	40	10	30	35	10	10	20	20	30	25	5	15	10	90	5	5	45	10
9	MP	MAJ(	50	60	50	50	30	10	10	50	50	60	20	40	20	50	60	80	10	10	75	75
21	MP	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
42	MP	NA	50	61	50	50	81	81	81	81	81	80	80	85	60	80	60	88	50	60	85	45
14	OD	MAJ	20	40	20	25	25	15	10	30	60	40	0	10	10	10	10	80	10	10	5	10
15	OD	LTC	60	25	80	20	50	60	41	41	75	25	25	75	50	100	60	90	61	21	75	75
16	OD	LTC	40	80	65	50	100	80	90	90	90	50	65	100	65	65	80	80	45	90	90	90
13	QM	MAJ	75	60	90	50	90	20	20	20	90	80	20	50	50	50	50	90	80	50	90	50
17	QM	MAJ	70	20	46	51	80	50	81	88	75	78	90	91	98	80	23	50	71	52	94	10
23	QM	MAJ	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
18	SC	MAJ	80	90	90	20	0	0	0	0	0	0	0	50	70	100	70	80	0	0	100	100
29	SC	LTC	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
30	TC	CPT	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Appendix M

Mean/ANOVA Data for Target Population by Sub-category

One-Way Analysis of Variance
All Respondents
Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	101672	2607	3.25	0.000
Error	2194	1757575	801		
Total	2233	1859247			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	------+---------+---------+---------+
C Terrai	62	64.48	26.49	(-----*-----)
C Task	62	68.34	22.14	(-----*-----)
C Simtor	60	67.00	25.92	(-----*-----)
C FComp	62	65.48	29.16	(-----*----)
C EComp	62	65.90	29.28	(-----*-----)
C PowRat	62	64.69	25.47	(-----*-----)
C ETkOrg	62	57.98	31.80	(-----*-----)
C EEquip	62	58.47	29.39	(-----*-----)
C FEquip	62	66.02	25.66	(-----*-----)
C AdUnit	62	57.65	26.93	(-----*-----)
C ETrnLv	62	51.82	30.60	(-----*-----)
C EMison	62	65.69	27.90	(-----*-----)
C Wether	62	51.47	30.76	(-----*-----)
C PreUse	62	70.42	22.34	(-----*-----)
C Diff	61	66.30	26.76	(-----*-----)
C Assmnt	61	77.75	21.08	(-----*-----)
C LtData	62	49.60	31.78	(-----*-----)
C ObDev	62	48.31	31.12	(-----*-----)
C ExPrep	62	66.77	28.42	(-----*-----)
C MnPlan	62	62.58	31.73	(-----*-----)
V Terran	50	65.54	27.42	(------*-----)
V Task	50	66.38	25.10	(-----*------)
V Sim	49	62.86	28.70	(-----*------)
V FComp	50	53.60	30.70	(------*-----)
V EComp	50	61.56	28.69	(-----*------)
V Ratio	50	58.36	24.75	(------*-----)
V ETaskO	50	51.42	31.88	(------*-----)
V EEquip	50	55.78	29.95	(-----*------)
V FEquip	50	64.36	25.32	(------*-----)
V AdjUnt	50	55.12	27.19	(------*-----)
V Trnlvl	50	51.72	31.92	(-----*------)
V EMsn	50	60.16	30.24	(-----*------)
V Wether	50	58.70	29.68	(------*-----)
V PrevU	50	65.70	25.42	(------*-----)
V LvlDif	50	63.14	26.67	(------*-----)
V UtAsmt	49	75.71	27.28	(------*------)
V LtDta	50	56.96	29.61	(-----*------)
V ObDev	50	61.40	30.94	(-----*------)
V ExPrp	50	58.80	30.58	(------*------)
V MsnPln	50	57.80	31.29	(-----*------)
				------+---------+---------+---------+
Pooled StDev =	28.30			48 60 72 84

Appendix N

Mean/ANOVA Data for the Air Defense Population

```
One-Way Analysis of Variance
Air Defense
Analysis of Variance
Source    DF      SS      MS      F      p
Factor    39   17320     444   0.55  0.982
Error    120   96432     804
Total    159  113752
                                Individual 95% CIs For Mean
                                Based on Pooled StDev
Level          N    Mean   StDev  ----+---------+---------+---------+--
C Terrai       4   81.25   15.48           (--------*--------)
C Task         4   57.50   26.30    (--------*---------)
C Simtor       4   62.50   27.54     (---------*--------)
C FComp        4   67.50   15.00      (---------*--------)
C EComp        4   65.00   17.32      (---------*--------)
C PowRat       4   67.50   20.62       (---------*--------)
C ETkOrg       4   61.25   29.55     (--------*---------)
C EEquip       4   61.25   29.55     (--------*---------)
C FEquip       4   73.75   17.02         (---------*--------)
C AdUnit       4   55.00   28.87    (--------*---------)
C ETrnLv       4   60.00   31.62     (--------*--------)
C EMison       4   62.50   34.03     (---------*--------)
C Wether       4   50.00   35.59  (---------*--------)
C PreUse       4   87.50    8.66             (--------*---------)
C Diff         4   82.50    2.89           (---------*--------)
C Assmnt       4   90.75    9.78             (--------*---------)
C LtData       4   46.25   28.69 (--------*---------)
C ObDev        4   52.50   37.75   (---------*--------)
C ExPrep       4   57.50   35.94    (--------*---------)
C MnPlan       4   61.25   39.66     (--------*---------)
V Terran       4   68.75   33.26        (--------*--------)
V Task         4   55.00   20.82    (--------*---------)
V Sim          4   48.75   33.26  (--------*---------)
V FComp        4   63.75   29.26      (--------*---------)
V EComp        4   63.75   17.97      (--------*---------)
V Ratio        4   62.50   20.62     (---------*--------)
V ETaskO       4   53.75   30.38    (--------*--------)
V EEquip       4   56.25   28.10    (---------*--------)
V FEquip       4   71.25   21.75        (---------*--------)
V AdjUnt       4   50.00   25.82  (---------*--------)
V Trnlvl       4   57.50   33.04    (--------*---------)
V EMsn         4   57.50   33.04    (--------*---------)
V Wether       4   52.50   27.54   (---------*--------)
V PrevU        4   72.50   22.55         (--------*---------)
V LvlDif       4   68.75   32.76        (--------*--------)
V UtAsmt       4   75.75   37.76          (--------*---------)
V LtDta        4   53.75   28.10    (--------*--------)
V ObDev        4   61.25   37.05      (--------*---------)
V ExPrp        4   50.00   33.67  (---------*--------)
V MsnPln       4   61.25   39.66      (--------*---------)
                                  ----+---------+---------+---------+--
Pooled StDev =  28.35                30        60        90       120
```

Appendix O

Mean/ANOVA Data for the Armor Population

One-Way Analysis of Variance

Armor

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	48958	1255	1.84	0.003
Error	260	176989	681		
Total	299	225947			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	-----+---------+---------+---------+-
C Terrai	8	50.62	23.97	(-----*-----)
C Task	8	65.00	27.26	(-----*-----)
C Simtor	8	71.25	32.71	(-----*-----)
C FComp	8	57.62	29.65	(-----*-----)
C EComp	8	47.62	29.22	(-----*-----)
C PowRat	8	57.00	24.36	(-----*-----)
C ETkOrg	8	48.87	22.55	(-----*-----)
C EEquip	8	44.38	27.96	(-----*-----)
C FEquip	8	53.75	30.68	(-----*-----)
C AdUnit	8	50.00	27.26	(-----*-----)
C ETrnLv	8	36.37	19.84	(-----*-----)
C EMison	8	49.50	25.37	(------*-----)
C Wether	8	33.25	30.57	(-----*-----)
C PreUse	8	71.87	22.35	(-----*-----)
C Diff	8	62.50	33.27	(-----*-----)
C Assmnt	8	78.13	17.31	(-----*-----)
C LtData	8	37.50	27.65	(------*-----)
C ObDev	8	45.63	24.41	(-----*-----)
C ExPrep	8	70.62	24.56	(------*-----)
C MnPlan	8	53.75	34.20	(-----*-----)
V Terran	7	77.14	9.51	(------*-----)
V Task	7	71.57	26.78	(------*-----)
V Sim	7	80.00	11.55	(------*-----)
V FComp	7	54.43	33.62	(-----*------)
V EComp	7	53.00	31.51	(------*-----)
V Ratio	7	55.86	26.40	(------*-----)
V ETaskO	7	58.00	28.57	(-----*------)
V EEquip	7	47.29	30.47	(------*-----)
V FEquip	7	56.57	30.40	(------*-----)
V AdjUnt	7	52.29	26.80	(-----*------)
V Trnlvl	7	42.86	22.89	(-----*------)
V EMsn	7	50.14	25.63	(------*-----)
V Wether	7	58.00	26.58	(-----*------)
V PrevU	7	75.00	22.17	(-----*-----)
V LvlDif	7	75.00	15.55	(-----*-----)
V UtAsmt	7	89.29	6.07	(------*-----)
V LtDta	7	65.00	21.41	(------*-----)
V ObDev	7	68.57	17.73	(------*-----)
V ExPrp	7	61.43	31.32	(-----*------)
V MsnPln	7	62.86	28.12	(------*-----)
				-----+---------+---------+---------+-
Pooled StDev =		26.09		30 60 90 120

Appendix P

Mean/ANOVA Data for the Aviation Population

```
One-Way Analysis of Variance
Aviation
Analysis of Variance
Source    DF      SS      MS      F       p
Factor    39   28721     736   0.94   0.577
Error    200  156746     784
Total    239  185467
                                     Individual 95% CIs For Mean
                                     Based on Pooled StDev
Level             N   Mean    StDev    ----+---------+---------+---------+--
C Terrai          6   51.67   38.04      (------*-------)
C Task            6   59.17   20.10       (-------*------)
C Simtor          6   65.00   26.65         (-------*------)
C FComp           6   58.33   30.61       (------*-------)
C EComp           6   74.17   12.81           (-------*------)
C PowRat          6   78.33   14.72            (------*-------)
C ETkOrg          6   58.33   31.89       (------*-------)
C EEquip          6   50.00   29.66     (-------*------)
C FEquip          6   61.67   21.37        (-------*------)
C AdUnit          6   60.00   24.49       (-------*-------)
C ETrnLv          6   53.33   25.82      (-------*------)
C EMison          6   71.67   27.87          (-------*------)
C Wether          6   63.33   28.05         (------*-------)
C PreUse          6   80.00   20.00            (-------*------)
C Diff            6   58.33   27.87       (------*-------)
C Assmnt          6   68.33   21.37         (-------*------)
C LtData          6   43.33   32.66  (------*-------)
C ObDev           6   40.83   36.66   (-------*------)
C ExPrep          6   85.00   13.78              (------*-------)
C MnPlan          6   73.33   32.04           (------*-------)
V Terran          6   60.00   35.21       (-------*-------)
V Task            6   67.50   23.61         (-------*------)
V Sim             6   68.33   28.58         (-------*------)
V FComp           6   54.17   36.93       (------*-------)
V EComp           6   74.17   13.57           (-------*------)
V Ratio           6   66.67   24.22         (------*-------)
V ETaskO          6   51.67   33.12      (------*-------)
V EEquip          6   61.67   35.45        (-------*------)
V FEquip          6   80.00   26.83            (-------*------)
V AdjUnt          6   71.67   30.61          (-------*------)
V Trnlvl          6   65.00   31.46         (-------*------)
V EMsn            6   65.00   33.32         (-------*------)
V Wether          6   86.67   15.06              (-------*------)
V PrevU           6   76.67   29.44            (-------*------)
V LvlDif          6   58.33   27.87       (------*-------)
V UtAsmt          6   60.00   32.25       (-------*-------)
V LtDta           6   68.33   29.27         (-------*------)
V ObDev           6   89.17   12.01               (-------*------)
V ExPrp           6   63.33   32.66         (------*-------)
V MsnPln          6   65.00   34.50         (-------*------)
                                       ----+---------+---------+---------+--
Pooled StDev = 28.00                      30        60        90       120
```

Appendix Q

Mean/ANOVA Data for the Field Artillery Population

One-Way Analysis of Variance
Field Artillery
Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	28225	724	0.94	0.577
Error	238	183279	770		
Total	277	211504			

```
                               Individual 95% CIs For Mean
                               Based on Pooled StDev
Level        N    Mean   StDev  ---------+---------+---------+-------
C Terrai     7   67.14   33.40      (-------*-------)
C Task       7   86.43   18.42           (--------*-------)
C Simtor     6   60.83   34.12   (--------*--------)
C FComp      7   85.00   22.55           (-------*-------)
C EComp      7   88.57   14.64            (-------*--------)
C PowRat     7   73.00   19.82       (-------*-------)
C ETkOrg     7   68.71   33.93      (-------*--------)
C EEquip     7   81.57   14.63          (--------*-------)
C FEquip     7   74.43   24.44        (-------*-------)
C AdUnit     7   64.43   26.47     (-------*-------)
C ETrnLv     7   74.29   24.23       (--------*-------)
C EMison     7   80.71   26.37         (-------*--------)
C Wether     7   61.43   40.59    (--------*-------)
C PreUse     7   70.00   28.43       (-------*-------)
C Diff       7   88.57    9.00           (-------*--------)
C Assmnt     7   94.00    7.66             (--------*-------)
C LtData     7   53.57   40.07  (-------*--------)
C ObDev      7   66.43   34.97     (--------*-------)
C ExPrep     7   77.43   27.68         (-------*-------)
C MnPlan     7   87.86   14.68            (-------*-------)
V Terran     7   75.00   33.79        (-------*-------)
V Task       7   85.71   15.12           (-------*--------)
V Sim        6   50.83   44.09 (--------*--------)
V FComp      7   64.43   36.52     (-------*-------)
V EComp      7   70.00   33.67       (-------*-------)
V Ratio      7   67.29   19.87      (-------*-------)
V ETaskO     7   64.43   34.17     (-------*-------)
V EEquip     7   77.29   12.58         (-------*-------)
V FEquip     7   70.86   21.76       (-------*--------)
V AdjUnt     7   62.29   24.59     (-------*-------)
V Trnlvl     7   72.14   25.80        (-------*-------)
V EMsn       7   66.43   38.48     (--------*-------)
V Wether     7   70.00   39.16       (-------*-------)
V PrevU      7   70.00   28.43       (-------*-------)
V LvlDif     7   87.14    7.56           (-------*-------)
V UtAsmt     7   89.71   15.07             (-------*-------)
V LtDta      7   70.71   35.41       (-------*--------)
V ObDev      7   84.29   18.35          (--------*-------)
V ExPrp      7   68.86   35.06      (--------*-------)
V MsnPln     7   76.43   28.39        (--------*-------)
                                ---------+---------+---------+-------
Pooled StDev =   27.75                   50        75       100
```

Appendix R

Mean/ANOVA Data for the Infantry Population

One-Way Analysis of Variance
Infantry
Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	50388	1292	1.55	0.020
Error	478	397869	832		
Total	517	448257			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	--+---------+---------+---------+----
C Terrai	16	72.50	20.17	(------*------)
C Task	16	73.75	15.55	(------*------)
C Simtor	15	64.33	26.31	(------*------)
C FComp	16	66.56	33.05	(------*------)
C EComp	16	61.56	35.44	(------*------)
C PowRat	16	67.81	25.03	(------*------)
C ETkOrg	16	55.63	36.28	(------*------)
C EEquip	16	59.56	31.94	(------*------)
C FEquip	16	69.25	24.10	(------*------)
C AdUnit	16	56.25	31.22	(------*------)
C ETrnLv	16	45.69	33.06	(------*------)
C EMison	16	61.56	30.97	(------*------)
C Wether	16	44.06	25.11	(------*------)
C PreUse	16	60.94	20.18	(------*-------)
C Diff	15	61.73	25.14	(------*------)
C Assmnt	16	69.69	24.18	(------*------)
C LtData	16	50.00	32.30	(------*------)
C ObDev	16	41.56	29.20	(------*------)
C ExPrep	16	53.12	29.49	(-------*------)
C MnPlan	16	57.44	32.47	(------*------)
V Terran	10	71.50	20.15	(--------*--------)
V Task	10	66.10	24.26	(--------*--------)
V Sim	10	67.50	28.10	(--------*--------)
V FComp	10	48.60	34.88	(--------*--------)
V EComp	10	54.00	32.98	(--------*--------)
V Ratio	10	59.00	21.32	(--------*-------)
V ETaskO	10	42.50	34.58	(--------*--------)
V EEquip	10	44.50	31.31	(--------*--------)
V FEquip	10	59.00	21.32	(--------*-------)
V AdjUnt	10	47.00	31.29	(--------*-------)
V Trnlvl	10	40.50	34.36	(--------*--------)
V EMsn	10	54.00	34.38	(--------*--------)
V Wether	10	41.00	26.01	(--------*-------)
V PrevU	10	58.00	22.01	(--------*--------)
V LvlDif	10	58.60	30.96	(--------*--------)
V UtAsmt	10	61.00	38.06	(--------*-------)
V LtDta	10	53.00	26.69	(--------*-------)
V ObDev	10	52.60	30.18	(--------*--------)
V ExPrp	10	35.80	21.85	(--------*--------)
V MsnPln	10	42.90	30.76	(--------*--------)
				--+---------+---------+---------+----
Pooled StDev =	28.85			20 40 60 80

Appendix S

Mean/ANOVA Data for the Military Police Population

One-Way Analysis of Variance
Military Police
Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	31181	800	1.12	0.306
Error	140	99595	711		
Total	179	130777			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	----------+---------+---------+------
C Terrai	5	49.20	31.00	(------*-------)
C Task	5	70.00	18.71	(-------*-------)
C Simtor	5	71.00	22.47	(-------*-------)
C FComp	5	60.00	33.91	(-------*-------)
C EComp	5	49.20	32.72	(------*-------)
C PowRat	5	50.20	32.06	(-------*-------)
C ETkOrg	5	49.20	37.02	(------*-------)
C EEquip	5	46.20	25.44	(------*-------)
C FEquip	5	50.20	21.57	(-------*-------)
C AdUnit	5	52.00	21.68	(-------*-------)
C ETrnLv	5	43.00	32.33	(-------*-------)
C EMison	5	54.00	23.82	(-------*-------)
C Wether	5	44.00	29.87	(-------*-------)
C PreUse	5	51.00	23.56	(-------*-------)
C Diff	5	48.00	22.80	(-------*-------)
C Assmnt	5	87.60	8.29	(-------*-------)
C LtData	5	42.00	34.02	(-------*-------)
C ObDev	5	38.00	30.54	(-------*-------)
C ExPrep	5	72.00	19.87	(-------*-------)
C MnPlan	5	58.00	33.65	(-------*-------)
V Terran	4	28.75	24.62	(--------*-------)
V Task	4	45.25	24.02	(--------*--------)
V Sim	4	40.00	14.14	(-------*--------)
V FComp	4	37.50	18.93	(--------*-------)
V EComp	4	50.25	24.90	(--------*--------)
V Ratio	4	46.50	30.75	(--------*-------)
V ETaskO	4	35.25	33.62	(--------*--------)
V EEquip	4	50.25	29.78	(--------*--------)
V FEquip	4	50.25	24.90	(--------*--------)
V AdjUnt	4	52.50	25.00	(--------*-------)
V Trnlvl	4	35.00	31.09	(--------*-------)
V EMsn	4	50.00	25.50	(--------*-------)
V Wether	4	36.25	28.10	(--------*--------)
V PrevU	4	51.25	27.20	(--------*--------)
V LvlDif	4	45.00	23.80	(--------*--------)
V UtAsmt	4	84.50	5.26	(--------*--------)
V LtDta	4	31.25	27.80	(-------*--------)
V ObDev	4	28.75	25.94	(--------*-------)
V ExPrp	4	68.75	17.02	(--------*--------)
V MsnPln	4	47.50	27.84	(--------*--------)
				----------+---------+---------+------
Pooled StDev =	26.67			30 60 90

Appendix T

Mean/ANOVA Data for the Quarter Master Population

One-Way Analysis of Variance
Quartermaster
Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	22148	568	0.88	0.658
Error	60	38646	644		
Total	99	60794			

Individual 95% CIs For Mean
Based on Pooled StDev

Level	N	Mean	StDev	--+---------+---------+---------+----
C Terrai	3	76.67	2.89	(------*------)
C Task	3	56.67	25.17	(------*------)
C Simtor	3	69.67	27.02	(------*-------)
C FComp	3	81.33	18.04	(------*-------)
C EComp	3	89.67	0.58	(------*-------)
C PowRat	3	52.00	32.51	(------*------)
C ETkOrg	3	61.33	35.92	(------*-------)
C EEquip	3	64.00	38.57	(------*------)
C FEquip	3	83.33	5.77	(------*------)
C AdUnit	3	81.00	1.73	(------*-------)
C ETrnLv	3	65.00	39.69	(------*-------)
C EMison	3	77.00	24.02	(------*-------)
C Wether	3	79.67	26.08	(------*------)
C PreUse	3	85.33	8.39	(------*-------)
C Diff	3	68.33	38.84	(------*------)
C Assmnt	3	76.00	16.37	(------*------)
C LtData	3	76.00	6.93	(------*------)
C ObDev	3	61.33	16.29	(------*-------)
C ExPrep	3	89.00	8.54	(------*-------)
C MnPlan	3	59.67	44.16	(------*------)
V Terran	2	72.50	3.54	(--------*--------)
V Task	2	40.00	28.28	(--------*--------)
V Sim	2	68.00	31.11	(--------*--------)
V FComp	2	50.50	0.71	(--------*--------)
V EComp	2	85.00	7.07	(--------*--------)
V Ratio	2	35.00	21.21	(--------*--------)
V ETaskO	2	50.50	43.13	(--------*--------)
V EEquip	2	54.00	48.08	(--------*-------)
V FEquip	2	82.50	10.61	(--------*--------)
V AdjUnt	2	79.00	1.41	(--------*--------)
V Trnlvl	2	55.00	49.50	(--------*--------)
V EMsn	2	70.50	28.99	(--------*--------)
V Wether	2	74.00	33.94	(--------*-------)
V PrevU	2	65.00	21.21	(--------*--------)
V LvlDif	2	36.50	19.09	(--------*--------)
V UtAsmt	2	70.00	28.28	(--------*-------)
V LtDta	2	75.50	6.36	(--------*--------)
V ObDev	2	51.00	1.41	(--------*--------)
V ExPrp	2	92.00	2.83	(--------*--------)
V MsnPln	2	30.00	28.28	(--------*-------)
				--+---------+---------+---------+----
Pooled StDev =	25.38			0 40 80 120

Appendix U

Mean/ANOVA Data for the Ground Maneuver Population

One-Way Analysis of Variance
Ground Maneuver
Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	70752	1814	2.34	0.000
Error	778	603723	776		
Total	817	674475			

Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev ---+---------+---------+---------+---
C Terrai	24	65.21	23.47	(------*------)
C Task	24	70.83	20.04	(------*------)
C Simtor	23	66.74	28.15	(------*------)
C FComp	24	63.58	31.60	(------*------)
C EComp	24	56.92	33.52	(------*------)
C PowRat	24	64.21	24.83	(------*------)
C ETkOrg	24	53.37	32.00	(------*------)
C EEquip	24	54.50	30.93	(------*------)
C FEquip	24	64.08	26.85	(------*------)
C AdUnit	24	54.17	29.51	(------*------)
C ETrnLv	24	42.58	29.20	(------*------)
C EMison	24	57.54	29.24	(------*------)
C Wether	24	40.46	26.89	(------*------)
C PreUse	24	64.58	21.11	(------*------)
C Diff	23	62.00	27.47	(------*------)
C Assmnt	24	72.50	22.12	(------*------)
C LtData	24	45.83	30.81	(------*------)
C ObDev	24	42.92	27.22	(------*------)
C ExPrep	24	58.96	28.67	(------*------)
C MnPlan	24	56.21	32.35	(------*------)
V Terran	17	73.82	16.44	(-------*-------)
V Task	17	68.35	24.65	(--------*-------)
V Sim	17	72.65	23.11	(-------*--------)
V FComp	17	51.00	33.42	(-------*-------)
V EComp	17	53.59	31.38	(-------*--------)
V Ratio	17	57.71	22.79	(-------*-------)
V ETaskO	17	48.88	32.26	(--------*-------)
V EEquip	17	45.65	30.02	(--------*-------)
V FEquip	17	58.00	24.57	(-------*--------)
V AdjUnt	17	49.18	28.76	(--------*-------)
V Trnlvl	17	41.47	29.36	(-------*-------)
V EMsn	17	52.41	30.25	(--------*-------)
V Wether	17	48.00	26.83	(-------*-------)
V PrevU	17	65.00	23.05	(--------*-------)
V LvlDif	17	65.35	26.44	(-------*-------)
V UtAsmt	17	72.65	32.17	(-------*--------)
V LtDta	17	57.94	24.69	(-------*--------)
V ObDev	17	59.18	26.38	(-------*-------)
V ExPrp	17	46.35	28.38	(-------*-------)
V MsnPln	17	51.12	30.52	(-------*-------)
				---+---------+---------+---------+---
Pooled StDev =	27.86			32 48 64 80

Appendix V

Mean/ANOVA Data for the Combat Support and Combat Service Support Population

One-Way Analysis of Variance

Combat Support and Combat Service Support

Analysis of Variance

Source	DF	SS	MS	F	p
Factor	39	59737	1532	2.01	0.000
Error	700	534718	764		
Total	739	594455			

Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev -----+---------+---------+---------+-
C Terrai	21	65.57	24.43	(-----*-----)
C Task	21	61.67	21.81	(-----*-----)
C Simtor	21	70.90	22.02	(----*-----)
C FComp	21	61.38	28.02	(-----*-----)
C EComp	21	64.29	28.41	(-----*-----)
C PowRat	21	56.57	28.69	(-----*-----)
C ETkOrg	21	56.71	31.97	(-----*-----)
C EEquip	21	54.71	27.85	(-----*-----)
C FEquip	21	65.29	25.20	(-----*-----)
C AdUnit	21	54.67	24.86	(-----*-----)
C ETrnLv	21	51.43	32.29	(-----*-----)
C EMison	21	66.48	26.80	(-----*-----)
C Wether	21	54.48	31.75	(-----*-----)
C PreUse	21	74.57	22.14	(-----*-----)
C Diff	21	66.67	26.89	(-----*-----)
C Assmnt	21	82.33	16.78	(-----*-----)
C LtData	21	53.52	30.42	(-----*-----)
C ObDev	21	49.24	31.31	(-----*-----)
C ExPrep	21	68.19	29.53	(-----*-----)
C MnPlan	21	59.52	32.43	(-----*-----)
V Terran	16	55.63	28.74	(------*------)
V Task	16	54.44	24.02	(------*------)
V Sim	16	55.38	25.95	(------*-----)
V FComp	16	48.19	24.63	(------*------)
V EComp	16	59.75	27.95	(------*------)
V Ratio	16	49.44	27.45	(------*------)
V ETaskO	16	44.25	30.88	(------*------)
V EEquip	16	51.56	29.41	(------*------)
V FEquip	16	63.19	25.92	(------*-----)
V AdjUnt	16	51.12	25.18	(------*-----)
V Trnlvl	16	45.31	33.49	(------*-----)
V EMsn	16	60.06	28.00	(------*------)
V Wether	16	52.06	26.60	(------*------)
V PrevU	16	61.88	27.50	(------*------)
V LvlDif	16	52.37	26.03	(------*------)
V UtAsmt	16	80.06	19.52	(------*------)
V LtDta	16	46.37	28.58	(------*------)
V ObDev	16	44.87	31.94	(-----*------)
V ExPrp	16	65.56	29.54	(------*------)
V MsnPln	16	54.37	31.83	(------*------)
				-----+---------+---------+---------+-
				40 60 80 100

Pooled StDev = 27.64

Appendix W

Comparison of Factors to Constructive Terrain Mean (z test)

Constructive Terrain vs. Constructive Enemy Task Organization

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_1^{\,2}}{n_2}}}$$

C Terrain	C Enemy Task Org				
90	90				
80	25				
60	80				
95	50				C Enemy Task Org
50	70		Count		62
50	25		Mean	64.48	57.98
80	75		Variance	701.83	1011.43
40	61		d o f		122
30	50			Z =	1.236512123
70	60		Pooled Var.	856.6267848	
10	40		Pooled Z=	1.236512123	
75	10		F-Test Two-Sample for Variances		
95	0				
0	90			C Terrain	C Enemy Task Org
75	50		Mean	63.89024844	57.57479367
10	80		Variance	702.1001763	990.0272354
70	70		Observations	64	64
60	60		df	63	63
60	80		F	0.709172588	
50	50		P(F<=f) one-tail	0.912312842	
75	81		F Critical one-tail	0.658619825	
50	90		Variances are not equal		
75	0				
80	80		t-Test: Two-Sample Assuming Unequal Variances		
90	50			C Terrain	C Enemy Task Org
0	80		Mean	63.89024844	57.57479367
100	100		Variance	702.1001763	990.0272354
90	85		Observations	64	64
95	95		Hypothesized Mean Difference	0	
75	0		df	122	
100	85		t Stat	1.228225432	
70	25		P(T<=t) one-tail	0.110863282	
80	80		t Critical one-tail	1.657440407	
40	80		P(T<=t) two-tail	0.221726564	
90	90		t Critical two-tail	1.97960162	
90	0		Means are Equal		
40	60				
70	10				
70	85				
50	60				
85	90				
75	5				
40	40				
100	90				
40	60				
5	10				
50	10				
90	85				
61	81				
21	22				
80	90				
90	90				
85	90				
20	10				
75	41				
41	80				
75	20				
75	79				
80	85				
80	0				
70	90				
80	75				
64.5	58				
26.5	31.8				

Constructive Terrain vs. Constructive Enemy Training Level

$$Z = \frac{(\bar{X}_1 - \bar{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_1^{\,2}}{n_2}}}$$

C Terrain	C E Train Lev				
90	90				
80	20				
60	80				
95	50				C E Train Level
50	50		Count		62
50	50		Mean		51.82
80	60		Variance	701.83	936.35
40	21		d o f		122
30	50			Z=	2.463167667
70	0		Pooled Var.	819.08633	
10	30			Pooled Z=	2.463167667
75	30		F-Test Two-Sample for Variances		
95	50			C Terrain	C E Train Level
0	50		Mean	63.89024844	51.49097401
75	50		Variance	702.1001763	913.6574453
10	100		Observations	64	64
70	50		df	63	63
60	20		F	0.768450123	
60	60		P(F<=f) one-tail	0.850742513	
50	50		F Critical one-tail	0.658619825	
75	90		Variances are not equal		
50	80				
75	65		t-Test: Two-Sample Assuming Unequal Variances		
80	80			C Terrain	C E Train Level
90	25		Mean	63.89024844	51.49097401
0	80		Variance	702.1001763	913.6574453
100	100		Observations	64	64
90	40		Hypothesized Mean Difference	0	
95	80		df	124	
75	0		t Stat	2.467732909	
100	21		P(T<=t) one-tail	0.007480449	
70	50		t Critical one-tail	1.657235771	
80	80		P(T<=t) two-tail	0.014960898	
40	90		t Critical two-tail	1.97927875	
90	90		Means are not equal.		
90	0				
40	70				
70	10				
70	60				
50	20				
85	75				
75	5				
40	40				
100	100				
40	10				
5	30				
50	20				
90	75				
61	80				
21	21				
80	90				
90	90				
85	70				
20	0				
75	25				
41	55				
75	20				
75	95				
80	80				
80	0				
70	60				
80	80				
64.5	51.8				
26.5	30.6				

Constructive Terrain vs. Constructive Weather

C Terrain	C Weathe
90	90
80	20
60	70
95	20
50	70
50	25
80	81
40	40
30	40
70	0
10	0
75	10
95	50
0	90
75	30
10	100
70	70
60	40
60	60
50	50
75	90
50	30
75	0
80	80
90	30
0	100
100	100
90	55
95	60
75	0
100	50
70	50
80	80
40	50
90	80
90	30
40	60
70	50
70	50
50	40
85	50
75	0
40	0
100	85
40	60
5	5
50	20
90	75
61	60
21	36
80	65
90	90
85	75
20	10
75	80
41	60
75	50
75	99
80	90
80	0
70	40
80	100
64.5	51.5
26.5	30.8

$$Z = \frac{(\bar{X}_1 - \bar{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

	C Terrain	C Weather
Count	62	62
Mean	64.48	51.47
Variance	701.83	945.89
d o f		122
	Z=	2.524852341
Pooled Var.	823.8599947	
	Pooled Z=	2.524852341

F-Test Two-Sample for Variances

	C Terrain	C Weather
Mean	63.89024844	51.14411102
Variance	702.1001763	922.5672212
Observations	64	64
df	63	63
F	0.761028747	
P(F<=f) one-tail	0.859441545	
F Critical one-tail	0.658619825	
Variances are not equal		

t-Test: Two-Sample Assuming Unequal Variances

	C Terrain	C Weather
Mean	63.89024844	51.14411102
Variance	702.1001763	922.5672212
Observations	64	64
Hypothesized Mean Difference	0	
df	124	
t Stat	2.529800945	
P(T<=t) one-tail	0.006332892	
t Critical one-tail	1.657235771	
P(T<=t) two-tail	0.012665784	
t Critical two-tail	1.97927875	
Means are not equal.		

Constructive Terrain vs. Constructive Light Data

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_1^{\,2}}{n_2}}}$$

C Terrain	C Light Dat				
90	80				
80	25				
60	60				
95	20				
50	70				
50	0				
80	60			C Terrain	C Light Data
40	40		Count	62	62
30	50		Mean	64.48	49.60
70	20		Variance	701.83	1009.85
10	0		d o f		122
75	60			Z=	2.833314132
95	50		Pooled Var.	855.8393707	
0	90			Pooled Z=	2.833314132
75	30				
10	10		F-Test Two-Sample for Variances		
70	70			C Terrain	C Light Data
60	10		Mean	63.89024844	49.31835827
60	60		Variance	702.1001763	982.753358
50	50		Observations	64	64
75	85		df	63	63
50	60		F	0.714421549	
75	0		P(F<=f) one-tail	0.907612175	
80	80		F Critical one-tail	0.658619825	
90	50		Variences are not equal.		
0	0				
100	100		t-Test: Two-Sample Assuming Unequal Variances		
90	85			C Terrain	C Light Data
95	75		Mean	63.89024844	49.31835827
75	50		Variance	702.1001763	982.753358
100	80		Observations	64	64
70	0		Hypothesized Mean Difference	0	
80	100		df	123	
40	20		t Stat	2.840042241	
90	80		P(T<=t) one-tail	0.002640112	
90	30		t Critical one-tail	1.657335815	
40	60		P(T<=t) two-tail	0.005280225	
70	10		t Critical two-tail	1.979437911	
70	70		Means are not equal.		
50	60				
85	60				
75	0				
40	20				
100	100				
40	60				
5	5				
50	10				
90	85				
61	50				
21	21				
80	90				
90	90				
85	15				
20	15				
75	61				
41	65				
75	80				
75	68				
80	80				
80	0				
70	50				
80	100				
64.5	49.6				
26.5	31.8				

Constructive Terrain vs. Constructive Observation Devices

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Terrain	C Observation Device				
90	80				C Observation Devic
80	20		Count		62
60	90		Mean		48.31
95	20		Variance		968.51
50	50		d o f		122
50	25			Z=	3.11675608
80	60		Pooled Var.	835.1693548	
40	40			Pooled Z=	3.11675608
30	50				
70	80		F-Test Two-Sample for Variances		
10	0			C Terrain	Observation Device
75	60		Mean	63.89024844	48.03792754
95	0		Variance	702.1001763	942.3794523
0	90		Observations	64	64
75	50		df	63	63
10	20		F	0.745029165	
70	75		P(F<=f) one-tail	0.877257588	
60	10		F Critical one-tail	0.658619825	
60	60		Variances are not equal		
50	30		t-Test: Two-Sample Assuming Unequal Variances		
75	85			C Terrain	Observation Device
50	60		Mean	63.89024844	48.03792754
75	70		Variance	702.1001763	942.3794523
80	100		Observations	64	64
90	50		Hypothesized Mean Difference	0	
0	0		df	123	
100	100		t Stat	3.127293147	
90	100		P(T<=t) one-tail	0.001101221	
95	50		t Critical one-tail	1.657335815	
75	50		P(T<=t) two-tail	0.002202442	
100	25		t Critical two-tail	1.979437911	
70	30		Means are not equal.		
80	80				
40	40				
90	80				
90	20				
40	70				
70	10				
70	40				
50	40				
85	30				
75	0				
40	0				
100	80				
40	40				
5	5				
50	10				
90	75				
61	60				
21	21				
80	90				
90	90				
85	20				
20	10				
75	25				
41	85				
75	50				
75	54				
80	80				
80	0				
70	60				
80	100				

Constructive Terrain vs. Virtual Friendly Composition

C Terrain	V F Com
90	20
80	75
60	80
95	80
50	90
50	
80	90
40	61
30	50
70	10
10	70
75	10
95	100
0	90
75	70
10	20
70	25
60	20
60	60
50	90
75	81
50	80
75	50
80	40
90	100
0	0
100	100
90	
95	21
75	
100	
70	
80	
40	40
90	
90	90
40	80
70	10
70	80
50	40
85	95
75	30
40	0
100	
40	40
5	10
50	50
90	
61	50
21	36
80	90
90	90
85	50
20	25
75	20
41	50
75	50
75	51
80	
80	20
70	
80	

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

	C Terrain	V F Comp
Count	62	50
Mean	64.48	53.60
Variance	701.83	942.29
d o f		110
	Z=	1.981655
Pooled Var.	808.9407625	
	Pooled Z=	2.013246

F-Test Two-Sample for Variances

	C Terrain	V F Comp
Mean	63.89024844	53.1595514
Variance	702.1001763	915.4210718
Observations	64	52
df	63	51
F	0.766969647	
P(F<=f) one-tail	0.835520886	
F Critical one-tail	0.63899197	

Variances are not equal

t-Test: Two-Sample Assuming Unequal Variances

	C Terrain	V F Comp
Mean	63.89024844	53.1595514
Variance	702.1001763	915.4210718
Observations	64	52
Hypothesized Mean Difference	0	
df	102	
t Stat	2.007419356	
P(T<=t) one-tail	0.023675053	
t Critical one-tail	1.659930149	
P(T<=t) two-tail	0.047350106	
t Critical two-tail	1.983494258	

Means are not equal.

Constructive Terrain vs. Virtual Enemy Task Organization

$$Z = \frac{(\bar{X}_1 - \bar{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Terrain	V Enemy Task Or				
90	30				V Enemy Task Org
80	25		Count		50
60	80		Mean		51.42
95	80		Variance		1016.33
50	70		d o f		110
50				Z=	2.32225388
80	75		Pooled Var.	841.924217	
40	61			Pooled Z=	2.368684493
30	50				
70	40		F-Test Two-Sample for Variances		
10	100				
75	10			C Terrain	V Enemy Task Org
95	0		Mean	63.89024844	51.0442295
0	90		Variance	702.1001763	983.8166979
75	30		Observations	64	52
10	80		df	63	51
70	50		F	0.71364938	
60	60		P(F<=f) one-tail	0.892741137	
60	60		F Critical one-tail	0.63899197	
50	50				
75	81		Variances are not equal		
50	90				
75	0		t-Test: Two-Sample Assuming Unequal Variances		
80	80				
90	50			C Terrain	V Enemy Task Org
0	50		Mean	63.89024844	51.0442295
100	100		Variance	702.1001763	983.8166979
90			Observations	64	52
95	50		Hypothesized Mean Difference	0	
75			df	100	
100			t Stat	2.349668342	
70			P(T<=t) one-tail	0.010377535	
80			t Critical one-tail	1.66023483	
40	80		P(T<=t) two-tail	0.020755069	
90			t Critical two-tail	1.983971742	
90	0		Means are not equal.		
40	60				
70	10				
70	100				
50	10				
85	50				
75	5				
40	60				
100					
40	40				
5	10				
50	10				
90					
61	81				
21	21				
80	90				
90	90				
85	70				
20	10				
75	41				
41	90				
75	20				
75	81				
80					
80	0				
70					
80					

Constructive Terrain vs. Virtual Enemy Equipment

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Terrai	V E Equi			
90	40			
80	25		Count	
60	80		Mean	
95	80		Variance	
50	70		d o f	
50				Z=
80	80		Pooled Var.	788.8005806
40	61			Pooled Z=
30	50			
70	0		F-Test Two-Sample for Variances	
10	60			
75	10			C Terrain
95	0		Mean	63.89024844
0	90		Variance	702.1001763
75	70		Observations	64
10	100		df	63
70	50		F	0.802654197
60	60		P(F<=f) one-tail	0.790536249
60	80		F Critical one-tail	0.63899197
50	50			
75	81		Variances are not equal	
50	60			
75	70		t-Test: Two-Sample Assuming Unequal Variances	
80	80			
90	70			C Terrain
0	80		Mean	63.89024844
100	100		Variance	702.1001763
90			Observations	64
95	50		Hypothesized Mean Difference	0
75			df	104
100			t Stat	1.632639824
70			P(T<=t) one-tail	0.052784479
80			t Critical one-tail	1.659636837
40	50		P(T<=t) two-tail	0.105568958
90			t Critical two-tail	1.983034963
90	80		Means are equal.	
40	20			
70	10			
70	90			
50	10			
85	70			
75	5			
40	60			
100				
40	60			
5	10			
50	50			
90				
61	81			
21	22			
80	90			
90	90			
85	75			
20	30			
75	41			
41	90			
75	20			
75	88			
80				
80	0			
70				
80				

Constructive Terrain vs. Virtual Adjacent Unit

C Terrain	V Adacent Uni
90	40
80	20
60	60
95	80
50	50
50	
80	80
40	61
30	40
70	0
10	60
75	75
95	100
0	90
75	50
10	80
70	90
60	20
60	60
50	75
75	81
50	30
75	75
80	40
90	60
0	50
100	100
90	
95	50
75	
100	
70	
80	
40	40
90	
90	0
40	10
70	30
70	80
50	60
85	30
75	100
40	70
100	
40	50
5	20
50	60
90	
61	80
21	26
80	50
90	90
85	70
20	40
75	25
41	50
75	80
75	78
80	
80	0
70	
80	

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

		V Adacent Unit
Count		50
Mean		55.12
Variance		739.41
d o f		110
	Z=	1.832601227
Pooled Var.	718.5705806	
	Pooled Z=	1.837775849

F-Test Two-Sample for Variances

	C Terrain	V Adacent Unit
Mean	63.89024844	54.58292626
Variance	702.1001763	725.4165612
Observations	64	52
df	63	51
F	0.967857937	
P(F<=f) one-tail	0.544849281	
F Critical one-tail	0.63899197	

Variances are not equal

t-Test: Two-Sample Assuming Unequal Variances

	C Terrain	V Adacent Unit
Mean	63.89024844	54.58292626
Variance	702.1001763	725.4165612
Observations	64	52
Hypothesized Mean Difference	0	
df	108	
t Stat	1.864426238	
P(T<=t) one-tail	0.032488605	
t Critical one-tail	1.659086593	
P(T<=t) two-tail	0.064977209	
t Critical two-tail	1.982170943	

Means are equal.

Constructive Terrain vs. Virtual Enemy Training Level

$$Z = \frac{(\bar{X}_1 - \bar{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Terrain	V E Train Lev				
90	40				V E Train Level
80	20		Count		50
60	90		Mean		51.72
95	80		Variance		1018.74
50	50		d o f		110
50				Z=	2.267202284
80	60		Pooled Var.	842.9960352	
40	40			Pooled Z=	2.312818086
30	50				
70	0		F-Test Two-Sample for Variances		
10	70				
75	30			C Terrain	V E Train Level
95	100		Mean	63.89024844	51.33918556
0	50		Variance	702.1001763	986.3269035
75	70		Observations	64	52
10	100		df	63	51
70	50		F	0.71183314	
60	20		P(F<=f) one-tail	0.894457172	
60	80		F Critical one-tail	0.63899197	
50	75				
75	90		Variances are not equal		
50	80				
75	50		t-Test: Two-Sample Assuming Unequal Variances		
80	80				
90	25			C Terrain	V E Train Level
0	80		Mean	63.89024844	51.33918556
100	100		Variance	702.1001763	986.3269035
90			Observations	64	52
95	50		Hypothesized Mean Difference	0	
75			df	100	
100			t Stat	2.29386627	
70			P(T<=t) one-tail	0.011945042	
80			t Critical one-tail	1.66023483	
40	90		P(T<=t) two-tail	0.023890084	
90			t Critical two-tail	1.983971742	
90	0		Means are not equal.		
40	70				
70	10				
70	90				
50	20				
85	50				
75	5				
40	20				
100					
40	10				
5	30				
50	20				
90					
61	80				
21	21				
80	90				
90	90				
85	60				
20	0				
75	25				
41	65				
75	20				
75	90				
80					
80	0				
70					
80					

Appendix X

Constructive vs. Virtual Factor Analysis (*z* test)

Terrain

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Terrain	V Terrain			
90	20			
80	80			
60	80			
95	95			
50	70			
80	90			Constructive
40	70		Count	50
30	70		Mean	60.46
70	80		Variance	743.31
10	70		d o f	
75	90			Z=
95	90		Pooled Var.	747.5187755
0	90			
75	50			
10	10			Pooled Z=
70	90			
60	30			
60	80			
50	75			
75	90			
50	80			
75	85			
80	80			
90	90			
0	0			
100	100			
95	95			
40	40			
90	90			
40	70			
70	50			
70	90			
50	50			
85	85			
75	85			
40	60			
40	10			
5	5			
50	50			
61	50			
21	22			
80	90			
90	90			
85	45			
20	20			
75	60			
41	40			
75	75			
75	70			
80	80			

Task

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_1^{\,2}}{n_2}}}$$

C Tas	V Tas				
70	30				
60	60				
80	80				
20	50				
50	50				
80	81			Constructive	Virtual
80	80		Count	50	50
90	90		Mean	66.54	66.38
10	20		Variance	538.38	630.08
90	90		d o f		98
70	90			Z=	0.033098
95	95				
50	90				
50	50		Pooled Var	584.2265306	
40	40				
50	80				
70	50			Pooled Z=	0.033098
40	80				
75	75				
100	100				
50	80				
95	60				
80	80				
100	100				
100	100				
80	80				
80	21				
80	80				
60	85				
60	90				
70	30				
95	60				
80	80				
85	65				
50	90				
60	60				
50	10				
50	50				
80	60				
80	61				
22	21				
90	90				
90	90				
80	80				
40	40				
25	25				
45	80				
60	60				
30	20				
90	90				

Simulator

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

	Constructive	Virtual
Count	49	49
Mean	64.80	62.86
Variance	679.58	823.63
d o f		96
	Z=	0.3500387
Pooled Var	751.6037415	
	Pooled Z=	0.3500387

C Simulator	V Simulator
80	20
50	50
30	30
90	95
90	90
90	90
80	80
80	80
10	60
30	70
90	90
90	90
90	90
50	50
20	20
70	90
70	70
80	60
80	80
90	90
20	10
80	80
25	25
50	0
100	100
95	21
60	60
50	90
30	80
70	70
80	99
60	60
95	95
80	80
20	20
60	20
40	40
75	50
80	50
26	24
50	90
90	90
75	40
20	20
80	80
85	65
90	90
39	46
90	90

Friendly Unit Composition

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

	Constructive	Virtual
Count	50	50
Mean	60.60	53.60
Variance	886.20	942.29
d o f		98
	Z=	1.157542
Pooled Var	914.244898	
	Pooled Z=	1.157542
z-Test: Two Sample for Means		

C F Com	V F Com
80	20
60	75
80	80
50	80
70	90
90	90
61	61
50	50
10	10
30	70
50	10
100	100
90	90
50	70
20	20
50	25
40	20
50	60
75	90
75	81
80	80
100	50
40	40
100	100
100	0
100	100
95	21
40	40
90	90
20	80
10	10
75	80
60	40
95	95
80	30
0	0
60	40
10	10
50	50
80	50
40	36
90	90
90	90
80	50
30	25
20	20
50	50
100	50
64	51
0	20

Enemy Composition

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_1^{\,2}}{n_2}}}$$

C E Com	V E Com			
90	40			
60	75			
60	60			
50	80			
90	90			
80	80			Constructive
61	61		Count	50
40	40		Mean	64.62
0	0		Variance	882.98
30	70		d o f	
30	30			Z=
85	90			
90	90			
80	70		Pooled Var.	853.082653
60	60			
70	75			
60	60			Pooled Z=
80	80			
75	75			
90	90			
100	100			
80	20			
60	60			
90	90			
100	30			
100	100			
95	50			
80	80			
100	100			
30	50			
10	10			
90	100			
60	40			
85	65			
5	5			
40	40			
10	60			
30	30			
40	30			
81	81			
40	31			
90	90			
90	90			
85	65			
30	25			
50	50			
100	100			
90	90			
89	80			
0	0			

Combat Power Ratio

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Power Rati	V Power Rati			
90	40			
50	50			
80	80			
50	80			
70	90			
90	80			Constructive
61	61		Count	50
50	50		Mean	62.42
60	40		Variance	651.19
40	60		d o f	
10	10			Z=
100	90			
90	90			
70	30		Pooled Var.	631.956122
80	80			
70	50			
60	60			Pooled Z=
80	80			
50	50			
81	81			
60	60			
90	50			
80	80			
50	50			
50	50			
100	100			
95	50			
80	80			
50	40			
40	60			
50	50			
90	100			
50	50			
90	50			
80	80			
60	30			
40	60			
35	35			
10	10			
81	81			
36	30			
90	90			
90	90			
85	65			
15	15			
41	60			
80	80			
20	20			
51	50			
0	0			

Enemy Task Organization

$$Z = \frac{(\bar{X}_1 - \bar{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_1^{\,2}}{n_2}}}$$

C Enemy Task Org	V Enemy Task Org				
90	30				
25	25				
80	80				
50	80				
70	70				
75	75			Constructive	Virtual
61	61		Count	50	50
50	50		Mean	55.60	51.42
60	40		Variance	1002.16	1016.33
40	100		d o f		98
10	10			Z=	0.657881403
0	0				
90	90				
50	30		Pooled Var.	1009.246735	
80	80				
70	50				
60	60			Pooled Z=	0.657881403
80	60				
50	50				
81	81				
90	90				
0	0				
80	80				
50	50				
80	50				
100	100				
95	50				
80	80				
0	0				
60	60				
10	10				
85	100				
60	10				
90	50				
5	5				
40	60				
60	40				
10	10				
10	10				
81	81				
22	21				
90	90				
90	90				
90	70				
10	10				
41	41				
80	90				
20	20				
79	81				
0	0				

Enemy Equipment

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C E Equi	V E Equi				
90	40				
25	25				
80	80				
50	80				
50	70				
80	80			Constructive	Virtual
50	61		Count	50	50
50	50		Mean	55.90	55.78
0	0		Variance	900.09	897.07
40	60		d o f		98
10	10			Z=	0.02001577
0	0				
90	90				
40	70		Pooled Var.	898.582449	
60	100				
50	50				
60	60			Pooled Z=	0.02001577
60	80				
30	50				
81	81				
60	60				
100	70				
80	80				
70	70				
80	80				
100	100				
95	50				
50	50				
75	80				
30	20				
10	10				
80	90				
60	10				
88	70				
5	5				
60	60				
40	60				
10	10				
50	50				
81	81				
22	22				
90	90				
90	90				
95	75				
40	30				
41	41				
85	90				
20	20				
92	88				
0	0				

Friendly Equipment

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C F Equi	V F Equi				
90	40				
75	75				
80	90				
50	80				
50	50				
100	100			Constructive	Virtual
50	61		Count	50	50
50	50		Mean	64.56	64.36
0	0		Variance	688.58	640.97
40	60		d o f		98
90	75			Z=	0.03878493
80	100				
90	90				
50	70		Pooled Var.	664.77388	
60	100				
60	90				
30	30			Pooled Z=	0.03878493
60	60				
30	75				
81	81				
30	30				
100	75				
60	60				
70	70				
80	80				
100	100				
95	50				
40	40				
75	80				
50	50				
50	30				
85	70				
60	60				
88	70				
100	100				
40	40				
50	50				
20	20				
50	50				
81	81				
18	20				
90	60				
90	90				
95	75				
70	60				
75	75				
80	90				
90	90				
80	75				
0	0				

Adjacent Unit

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\ 2}}{n_1} + \frac{\sigma_1^{\ 2}}{n_2}}}$$

	Constructive	Virtual
Count	50	50
Mean	56.38	55.12
Variance	758.98	739.41
d o f		98
	Z=	0.230167109
Pooled Var.	749.1944898	
	Pooled Z=	0.230167109

C Adacent Uni	V Adacent Uni
90	40
20	20
60	60
50	80
50	50
80	80
50	61
40	40
0	0
40	60
90	75
80	100
90	90
50	50
60	80
60	90
20	20
60	60
30	75
81	81
30	30
90	75
40	40
60	60
50	50
100	100
95	50
40	40
0	0
10	10
50	30
50	80
60	60
60	30
100	100
70	70
50	50
20	20
60	60
80	80
40	26
90	50
90	90
95	70
50	40
25	25
50	50
80	80
83	78
0	0

Enemy Training Level

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_1^{\,2}}{n_2}}}$$

C E Train Lev	V E Train Lev				
90	40				
20	20				
80	90				
50	80				
50	50				
60	60			Constructive	Virtual
21	40		Count	50	50
50	50		Mean	49.74	51.72
0	0		Variance	945.99	1018.74
30	70		d o f		98
30	30			Z=	-0.315863114
50	100				
50	50				
50	70		Pooled Var.	982.3642857	
100	100				
50	50				
20	20			Pooled Z=	-0.315863114
60	80				
50	75				
90	90				
80	80				
65	50				
80	80				
25	25				
80	80				
100	100				
80	50				
90	90				
0	0				
70	70				
10	10				
60	90				
20	20				
75	50				
5	5				
40	20				
10	10				
30	30				
20	20				
80	80				
21	21				
90	90				
90	90				
70	60				
0	0				
25	25				
55	65				
20	20				
95	90				
0	0				

Enemy Mission

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C E Missi	V E Missi				
90	40				
20	20				
90	90				
50	80				
70	70				
90	80			Constructive	Virtual
41	21		Count	50	50
40	60		Mean	63.76	60.16
20	20		Variance	804.31	914.63
30	70		d o f		98
30	30			Z=	0.61398493
100	100				
80	80				
30	40		Pooled Var.	859.467755	
100	100				
50	50				
70	20			Pooled Z=	0.61398493
80	80				
75	75				
95	95				
90	90				
75	75				
80	80				
25	25				
100	0				
100	100				
85	50				
90	90				
70	70				
70	70				
10	10				
80	100				
60	20				
60	50				
0	0				
60	80				
50	50				
25	25				
40	40				
85	85				
41	41				
90	90				
90	90				
80	80				
10	10				
75	75				
100	100				
50	50				
96	91				
50	50				

Weather

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

	Constructive	Virtual
Count	50	50
Mean	49.22	58.70
Variance	955.15	881.15
d o f		98
	Z=	-1.564302
Pooled Var.	918.1538776	
	Pooled Z=	-1.564302

C Weathe	V Weather
90	40
20	20
70	70
20	80
70	90
81	81
40	60
40	70
0	45
0	50
10	10
50	100
90	90
30	80
100	100
70	90
40	60
60	60
50	75
90	90
30	90
0	0
80	80
30	30
100	100
100	100
60	50
50	50
30	0
60	80
50	50
50	50
40	60
50	50
0	0
0	20
60	60
5	5
20	20
60	60
36	36
65	90
90	90
75	60
10	10
80	50
60	65
50	50
99	98
0	70

Previous Use

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Previous Use	V Previous Use				
90	40				
75	75				
90	90				
95	85				
70	70				
90	90			Constructive	Virtual
80	80		Count	50	50
75	75		Mean	71.12	65.70
80	80		Variance	445.58	645.93
100	100		d o f		98
30	30			Z =	1.160035505
100	100				
50	50				
90	90		Pooled Var.	545.7528571	
100	100				
70	90				
70	30			Pooled Z=	1.160035505
60	40				
50	50				
75	75				
70	70				
80	80				
40	40				
25	25				
100	100				
100	100				
70	60				
50	50				
60	90				
70	80				
70	20				
50	70				
60	40				
50	50				
80	80				
60	40				
60	60				
15	15				
50	50				
80	80				
40	40				
90	50				
90	90				
60	60				
80	10				
100	100				
55	65				
80	50				
81	80				
100	100				

Level of Difficulty

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\,2}}{n_1} + \frac{\sigma_1^{\,2}}{n_2}}}$$

C Difficult	V Difficult				
80	20				
85	85				
80	80				
85	90				
70	70				
90	90			Constructive	Virtual
70	80		Count	50	50
50	50		Mean	63.68	63.14
10	85		Variance	672.51	711.35
20	60		d o f		98
90	90			Z=	0.102643973
50	50				
50	50				
50	50		Pooled Var.	691.927551	
100	100				
80	80				
20	20			Pooled Z=	0.102643973
60	40				
50	50				
90	90				
80	80				
100	90				
80	80				
90	90				
80	80				
100	100				
21	21				
50	50				
65	100				
50	95				
70	20				
50	70				
60	40				
50	50				
100	100				
50	40				
50	50				
10	10				
70	60				
60	60				
38	38				
90	90				
90	90				
30	30				
15	10				
90	60				
90	80				
80	50				
25	23				
70	70				

Unit Assessment

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Assesmen	V Assesmen				
80	20				
85	85				
100	100				
98	98				
90	90				
90	90			Constructive	Virtual
70	80		Count	49	49
90	90		Mean	77.61	75.71
60	85		Variance	439.53	744.13
100	100		d o f		96
50	90			Z=	0.386163839
70	70		Pooled Var.	591.8295068	
90	90			Pooled Z=	0.386163839
30	30		F-Test Two-Sample for Variances		
80	100				
80	50			C Assesment	V Assesment
60	20		Mean	77.6122449	75.71428571
80	80		Variance	439.5340136	744.125
90	90		Observations	49	49
98	98		df	48	48
80	80		F	0.590672284	
90	60		P(F<=f) one-tail	0.964391517	
100	100		F Critical one-tail	0.619053253	
90	90				
100	100				
100	100				
50	5				
20	20				
80	90				
70	100				
50	50				
85	85				
60	40				
30	20				
80	100				
100	100				
80	80				
90	90				
80	80				
88	88				
21	21				
90	90				
95	95				
90	80				
90	90				
75	80				
90	90				
58	50				
80	80				

Light Data

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

	Constructive	Virtual
Count	50	50
Mean	45.30	56.96
Variance	874.62	876.65
d o f		98
	Z =	-1.970182775
Pooled Var.	875.6369388	
	Pooled Z=	-1.970182775

C Light Dat	V Light Dat
80	40
25	25
60	60
20	90
70	90
60	60
40	80
50	50
20	85
0	30
60	60
50	100
90	90
30	50
10	20
70	70
10	80
60	60
50	75
85	85
60	80
0	0
80	80
50	50
0	100
100	100
75	50
20	20
30	90
60	60
10	90
70	70
60	60
60	50
0	20
20	20
60	60
5	5
10	10
50	50
21	21
90	90
90	90
15	15
15	10
61	61
65	45
80	80
68	71
0	0

Observation Devices

C Observation Device	V Observation Device
80	40
20	20
90	90
20	95
50	90
60	90
40	80
50	50
80	60
0	50
60	60
0	100
90	90
50	70
20	100
75	95
10	80
60	60
30	75
85	85
60	80
70	75
100	100
50	50
0	100
100	100
50	21
40	40
20	100
70	70
10	10
40	45
40	60
30	80
0	80
0	20
40	40
5	5
10	10
60	60
21	21
90	90
90	90
20	20
10	10
25	21
85	90
50	50
54	52
0	0

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

	Constructive	Virtual
Count	50	50
Mean	44.20	61.40
Variance	951.02	957.22
d o f		98
	Z=	-2.784174132
Pooled Var.	954.122449	
	Pooled Z=	-2.784174132

Exercise preparation

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^{\ 2}}{n_1} + \frac{\sigma_1^{\ 2}}{n_2}}}$$

	Constructive	Virtual
Count	50	50
Mean	68.10	58.80
Variance	775.68	934.86
d o f		98
	Z =	1.590015
Pooled Var.	855.2704082	
	Pooled Z=	1.590015

C Exercise Pre	V Exercise Pre
50	40
10	10
90	90
80	60
50	50
90	90
70	80
90	80
80	20
20	20
90	90
100	100
90	90
70	30
100	80
80	60
70	20
50	40
90	80
92	92
70	70
100	100
80	80
20	20
80	20
100	100
95	25
40	40
0	0
80	20
30	30
75	33
40	60
50	40
80	80
40	30
60	70
45	45
75	75
85	85
21	21
80	80
90	90
50	50
5	5
75	75
90	90
90	90
97	94
100	100

Mission Planning

$$Z = \frac{(\overline{X}_1 - \overline{X}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_1^2}{n_2}}}$$

C Mission Planni	V Mission Planni				
50	50				
10	10				
90	90				
95	95				
30	30				
90	90			Constructive	Virtual
80	80		Count	50	50
70	70		Mean	63.10	57.80
20	60		Variance	1081.19	978.98
0	20		d o f		98
90	90			Z=	0.825675
100	100				
80	80				
20	20		Pooled Var.	1030.086735	
100	100				
90	60				
50	30			Pooled Z=	0.825675
50	50				
50	50				
85	85				
60	60				
100	100				
80	80				
90	90				
100	20				
100	100				
95	20				
40	40				
0	0				
80	50				
70	70				
99	89				
40	40				
90	40				
80	80				
0	0				
60	60				
10	10				
75	75				
45	45				
21	21				
80	80				
90	90				
35	35				
10	10				
75	75				
81	90				
90	50				
9	10				
100	100				

Appendix Y

Constructive vs. Virtual Factor Analysis (chi-square)

Chi-Square Test
Adjacent Unit

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	8	8	22	11	13	62
	8.30	9.96	19.38	13.29	11.07	
2	7	10	13	13	7	50
	6.70	8.04	15.62	10.71	8.93	
Total	15	18	35	24	20	112

ChiSq = 0.011 + 0.387 + 0.356 + 0.393 + 0.336 +
0.014 + 0.480 + 0.441 + 0.488 + 0.417 = 3.322
df = 4, p = 0.506

Chi-Square Test
Unit Assesment

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	1	4	8	19	29	61
	3.33	3.88	6.65	15.53	31.61	
2	5	3	4	9	28	49
	2.67	3.12	5.35	12.47	25.39	
Total	6	7	12	28	57	110

ChiSq = 1.628 + 0.004 + 0.272 + 0.777 + 0.215 +
2.026 + 0.004 + 0.339 + 0.967 + 0.268 = 6.500
df = 4, p = 0.166
4 cells with expected counts less than 5.0

Chi-Square Test
Level of Difficulty

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	5	5	17	13	21	61
	5.50	6.59	16.49	12.64	19.78	
2	5	7	13	10	15	50
	4.50	5.41	13.51	10.36	16.22	
Total	10	12	30	23	36	111

ChiSq = 0.045 + 0.386 + 0.016 + 0.010 + 0.075 +
0.055 + 0.470 + 0.020 + 0.013 + 0.091 = 1.179
df = 4, p = 0.881
1 cells with expected counts less than 5.0

Chi-Square Test
Enemy Composition

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	6	10	9	13	24	62
	6.09	11.07	9.41	14.39	21.04	
2	5	10	8	13	14	50
	4.91	8.93	7.59	11.61	16.96	
Total	11	20	17	26	38	112

ChiSq = 0.001 + 0.104 + 0.018 + 0.135 + 0.418 +
0.002 + 0.129 + 0.022 + 0.167 + 0.518 = 1.513
df = 4, p = 0.824
1 cells with expected counts less than 5.0

Chi-Square Test
Enemy Equipment

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	9	8	17	11	17	62
	10.52	6.64	16.05	13.84	14.95	
2	10	4	12	14	10	50
	8.48	5.36	12.95	11.16	12.05	
Total	19	12	29	25	27	112

ChiSq = 0.219 + 0.277 + 0.056 + 0.583 + 0.282 +
0.272 + 0.344 + 0.069 + 0.722 + 0.350 = 3.174
df = 4, p = 0.530

Chi-Square Test
Enemy Mission

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	6	7	11	18	20	62
	7.75	7.75	10.52	17.71	18.27	
2	8	7	8	14	13	50
	6.25	6.25	8.48	14.29	14.73	
Total	14	14	19	32	33	112

ChiSq = 0.395 + 0.073 + 0.022 + 0.005 + 0.164 +
0.490 + 0.090 + 0.027 + 0.006 + 0.204 = 1.475
df = 4, p = 0.831

Chi-Square Test
Enemy Task Organization

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	12	6	11	14	19	62
	13.29	6.64	12.73	12.73	16.61	
2	12	6	12	9	11	50
	10.71	5.36	10.27	10.27	13.39	
Total	24	12	23	23	30	112

ChiSq = 0.124 + 0.062 + 0.236 + 0.126 + 0.345 +
0.154 + 0.077 + 0.292 + 0.157 + 0.428 = 2.001
df = 4, p = 0.736

Chi-Square Test
Enemy Training Level

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	13	10	15	14	10	62
	14.39	9.41	13.29	13.84	11.07	
2	13	7	9	11	10	50
	11.61	7.59	10.71	11.16	8.93	
Total	26	17	24	25	20	112

ChiSq = 0.135 + 0.037 + 0.221 + 0.002 + 0.104 +
0.167 + 0.046 + 0.274 + 0.002 + 0.129 = 1.117
df = 4, p = 0.892

Chi-Square Test
Exercise Preparation

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	6	8	7	21	20	62
	8.30	9.96	7.20	17.71	18.82	
2	9	10	6	11	14	50
	6.70	8.04	5.80	14.29	15.18	
Total	15	18	13	32	34	112

ChiSq = 0.639 + 0.387 + 0.005 + 0.609 + 0.074 +
0.792 + 0.480 + 0.007 + 0.756 + 0.092 = 3.841
df = 4, p = 0.428

Chi-Square Test
Friendly Composition

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	8	6	12	17	19	62
	10.52	8.30	11.63	14.39	17.16	
2	11	9	9	9	12	50
	8.48	6.70	9.37	11.61	13.84	
Total	19	15	21	26	31	112

ChiSq = 0.603 + 0.639 + 0.012 + 0.472 + 0.197 +
0.747 + 0.792 + 0.015 + 0.586 + 0.244 = 4.308
df = 4, p = 0.367

Chi-Square Test
Friendly Equipment

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	4	7	17	15	19	62
	4.43	7.20	16.05	16.61	17.71	
2	4	6	12	15	13	50
	3.57	5.80	12.95	13.39	14.29	
Total	8	13	29	30	32	112

ChiSq = 0.041 + 0.005 + 0.056 + 0.156 + 0.093 +
0.051 + 0.007 + 0.069 + 0.193 + 0.116 = 0.787
df = 4, p = 0.940
2 cells with expected counts less than 5.0

Chi-Square Test
Light Data

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	18	5	16	13	10	62
	15.50	4.98	16.61	12.73	12.18	
2	10	4	14	10	12	50
	12.50	4.02	13.39	10.27	9.82	
Total	28	9	30	23	22	112

ChiSq = 0.403 + 0.000 + 0.022 + 0.006 + 0.390 +
0.500 + 0.000 + 0.028 + 0.007 + 0.483 = 1.839
df = 4, p = 0.765
2 cells with expected counts less than 5.0

Chi-Square Test
Mission Planning

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	9	9	9	14	21	62
	10.52	8.86	10.52	12.73	19.38	
2	10	7	10	9	14	50
	8.48	7.14	8.48	10.27	15.62	
Total	19	16	19	23	35	112

ChiSq = 0.219 + 0.002 + 0.219 + 0.126 + 0.136 +
0.272 + 0.003 + 0.272 + 0.157 + 0.169 = 1.575
df = 4, p = 0.813

Chi-Square Test
Observation Devices

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	16	12	14	10	10	62
	13.29	9.96	13.84	10.52	14.39	
2	8	6	11	9	16	50
	10.71	8.04	11.16	8.48	11.61	
Total	24	18	25	19	26	112

ChiSq = 0.555 + 0.416 + 0.002 + 0.025 + 1.341 +
0.688 + 0.516 + 0.002 + 0.032 + 1.663 = 5.238
df = 4, p = 0.265

Chi-Square Test
Combat Power Ratio

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	6	5	15	17	19	62
	6.09	6.64	18.27	15.50	15.50	
2	5	7	18	11	9	50
	4.91	5.36	14.73	12.50	12.50	
Total	11	12	33	28	28	112

ChiSq = 0.001 + 0.406 + 0.585 + 0.145 + 0.790 +
0.002 + 0.504 + 0.725 + 0.180 + 0.980 = 4.318
df = 4, p = 0.365
1 cells with expected counts less than 5.0

Chi-Square Test
Previous Use

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	2	5	16	19	20	62
	2.77	7.75	14.39	18.27	18.82	
2	3	9	10	14	14	50
	2.23	6.25	11.61	14.73	15.18	
Total	5	14	26	33	34	112

ChiSq = 0.213 + 0.976 + 0.179 + 0.029 + 0.074 +
0.264 + 1.210 + 0.223 + 0.036 + 0.092 = 3.296
df = 4, p = 0.510
2 cells with expected counts less than 5.0

Chi-Square Test
Simulator

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	5	9	8	21	17	60
	6.61	8.26	9.36	17.61	18.17	
2	7	6	9	11	16	49
	5.39	6.74	7.64	14.39	14.83	
Total	12	15	17	32	33	109

ChiSq = 0.390 + 0.067 + 0.197 + 0.651 + 0.075 +
0.478 + 0.082 + 0.241 + 0.797 + 0.092 = 3.069
df = 4, p = 0.547

Chi-Square Test
Task

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	3	7	11	14	15	50
	2.23	5.80	12.50	16.07	13.39	
2	2	6	17	22	15	62
	2.77	7.20	15.50	19.93	16.61	
Total	5	13	28	36	30	112

ChiSq = 0.264 + 0.247 + 0.180 + 0.267 + 0.193 +
0.213 + 0.199 + 0.145 + 0.215 + 0.156 = 2.079
df = 4, p = 0.721
2 cells with expected counts less than 5.0

Chi-Square Test
Terrain

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	6	7	10	24	15	62
	6.64	6.09	9.96	21.59	17.71	
2	6	4	8	15	17	50
	5.36	4.91	8.04	17.41	14.29	
Total	12	11	18	39	32	112

ChiSq = 0.062 + 0.136 + 0.000 + 0.269 + 0.416 +
0.077 + 0.169 + 0.000 + 0.334 + 0.516 = 1.979
df = 4, p = 0.740
1 cells with expected counts less than 5.0

Chi-Square Test
Weather

Expected counts are printed below observed counts

	V. Sm CH	Sm. CH	C. Effct	Hi CH	V. Hi CH	Total
1	13	11	16	10	12	62
	12.18	7.75	17.71	10.52	13.84	
2	9	3	16	9	13	50
	9.82	6.25	14.29	8.48	11.16	
Total	22	14	32	19	25	112

ChiSq = 0.055 + 1.363 + 0.166 + 0.025 + 0.244 +
0.069 + 1.690 + 0.206 + 0.032 + 0.303 = 4.153
df = 4, p = 0.386

Appendix Z

General Maneuver and Combat Service and Combat Service Support Frequency Tables

Constructive Factors

Factor	Very Small Chance	Small Chance	Could Effect	High Chance	Very High Chance
C Terrain	**1**	**5**	**3**	**9**	**6**
C Terrain	*2*	*1*	*5*	*9*	*4*
C Task	**1**	**0**	**8**	**9**	**6**
C Task	*1*	*4*	*5*	*9*	*2*
C Simulator	**2**	**4**	**3**	**7**	**7**
C Simulator	*1*	*3*	*2*	*10*	*5*
C F Comp	**4**	**2**	**4**	**6**	**8**
C F Comp	*3*	*1*	*6*	*8*	*3*
C E Comp	**4**	**6**	**2**	**5**	**7**
C E Comp	*2*	*3*	*4*	*5*	*7*
C Power Ratio	**2**	**2**	**6**	**8**	**6**
C Power Ratio	*4*	*2*	*5*	*5*	*5*
C Enemy Task Org	**5**	**4**	**4**	**5**	**6**
C Enemy Task Org	*5*	*1*	*4*	*5*	*6*
C E Equip	**5**	**2**	**7**	**5**	**5**
C E Equip	*3*	*4*	*6*	*3*	*5*
C F Equip	**1**	**4**	**8**	**3**	**8**
C F Equip	*2*	*1*	*5*	*9*	*4*
C Adjacent Unit	**4**	**3**	**8**	**5**	**4**
C Adjacent Unit	*3*	*2*	*5*	*9*	*2*
C E Train Level	**6**	**6**	**6**	**4**	**2**
C E Train Level	*6*	*2*	*5*	*5*	*3*
C E Mission	**4**	**3**	**5**	**7**	**5**
C E Mission	*2*	*2*	*4*	*6*	*7*
C Weather	**6**	**5**	**3**	**9**	**1**
C Weather	*6*	*1*	*6*	*3*	*5*
C Previous Use	**1**	**2**	**8**	**9**	**4**
C Previous Use	*1*	*0*	*6*	*5*	*9*
C Difficulty	**2**	**2**	**8**	**4**	**7**
C Difficulty	*2*	*1*	*6*	*5*	*7*
C Assessment	**1**	**1**	**6**	**7**	**9**
C Assessment	*0*	*1*	*1*	*8*	*11*
C Light Data	**8**	**2**	**7**	**5**	**2**
C Light Data	*5*	*1*	*6*	*6*	*3*
C Observation Devices	**5**	**8**	**6**	**5**	**1**
C Observation Devices	*6*	*3*	*4*	*5*	*3*
C Exercise Prep	**3**	**5**	**2**	**10**	**4**
C Exercise Prep	*2*	*2*	*4*	*4*	*9*
C Mission Planning	**4**	**5**	**2**	**8**	**5**
C Mission Planning	*4*	*2*	*5*	*3*	*7*

Factor frequencies in Bold Face are Maneuver
Factor frequencies in Italics are CS and CSS

Appendix AA

Corrected General Maneuver and Combat Service and Combat Service Support Frequency

Factor Tables and Analysis

Revised Frequency Table

Factor	Small	Could	High	Factor	Small	Could	High
C Terrain	6	3	15	**V Terrain**	1	3	13
C Terrain	3	5	13	*V Terrain*	5	3	8
C Task	1	8	15	**V Task**	3	3	11
C Task	5	5	11	*V Task*	5	5	6
C Simulator	6	3	14	**V Simulator**	2	3	12
C Simulator	4	2	15	*V Simulator*	5	5	6
C F Comp	6	4	14	**V F Comp**	8	1	8
C F Comp	4	6	11	*V F Comp*	6	6	4
C E Comp	10	2	12	**V E Comp**	7	2	8
C E Comp	5	4	12	*V E Comp*	5	3	8
C Power Ratio	4	6	14	**V Power Ratio**	4	7	6
C Power Ratio	6	5	10	*V Power Ratio*	6	5	5
C Enemy Task Org	9	4	11	**V Enemy Task Org**	6	5	6
C Enemy Task Org	6	4	11	*V Enemy Task Org*	8	3	5
C E Equip	7	7	10	**V E Equip**	6	5	6
C E Equip	7	6	8	*V E Equip*	6	4	6
C F Equip	5	8	11	**V F Equip**	4	6	7
C F Equip	3	5	13	*V F Equip*	3	4	9
C Adjacent Unit	7	8	9	**V Adjacent Unit**	7	4	6
C Adjacent Unit	5	5	11	*V Adjacent Unit*	6	5	5
C E Train Level	12	6	6	**V E Train Level**	8	5	4
C E Train Level	8	5	8	*V E Train Level*	9	0	7
C E Mission	7	5	12	**V E Mission**	6	3	8
C E Mission	4	4	13	*V E Mission*	5	3	8
C Weather	11	3	10	**V Weather**	4	9	4
C Weather	7	6	8	*V Weather*	5	5	6
C Previous Use	3	8	13	**V Previous Use**	4	3	10
C Previous Use	1	6	14	*V Previous Use*	4	4	8
C Difficulty	4	8	11	**V Difficulty**	4	4	9
C Difficulty	3	6	12	*V Difficulty*	5	6	5
C Assessment	2	6	16	**V Assessmen**	4	1	12
C Assessmen	1	1	19	*V Assessmen*	1	1	14
C Light Data	10	7	7	**V Light Data**	4	7	6
C Light Data	6	6	9	*V Light Data*	6	5	5
C Observation Devices	13	6	6	**V Observation Devices**	4	6	7
C Observation Devices	9	4	8	*V Observation Devices*	8	4	4
C Exercise Prep	8	2	14	**V Exercise Prep**	10	2	5
C Exercise Prep	4	4	13	*V Exercise Prep*	4	2	10
C Mission Planning	9	2	13	**V Mission Planning**	8	2	7
C Mission Planning	6	5	10	*V Mission Planning*	4	6	6

Bold Factors are Ground Maneuver

Italic Factors are Combat Service and Combat Service Support

Table Statistics for Constructive Terrain			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	1.449	2	0.484
Continuity Adjusted Chi-Square	0.514	2	0.773
Likelihood Ratio Chi-Square	1.468	2	0.480
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.179		
Contigency	0.177		
Cramer's V	0.179		
Goodman-Kruskal Gamma	0.065		0.271
Kendalls tau-b	0.034		0.142
Stuart's tau-c	0.036		0.148
Somer's D (C|R)	0.036		0.149

Warning: More than 1/5 of Fitted Cells are Sparse

Table Statistics for Constructive Task			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	3.791	2	0.150
Continuity Adjusted Chi-Square	2.096	2	0.351
Likelihood Ratio Chi-Square	4.027	2	0.134
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.290		
Contigency	0.279		
Cramer's V	0.290		
Goodman-Kruskal Gamma	-0.293		0.249
Kendalls tau-b	-0.160		0.141
Stuart's tau-c	-0.170		0.152
Somer's D (C|R)	-0.171		0.152

Table Statistics for Constructive Simulator			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.545	2	0.762
Continuity Adjusted Chi-Square	C.090	2	0.956
Likelihood Ratio Chi-Square	0.548	2	0.760
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.111		
Contigency	0.111		
Cramer's V	0.111		
Goodman-Kruskal Gamma	0.210		0.283
Kendalls tau-b	0.105		0.144
Stuart's tau-c	0.105		0.144
Somer's D (C|R)	0.106		0.144

Warning: More than 1/5 of Fitted Cells are Sparse

Table Statistics for Constructive Friendly Composition			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.964	2	0.617
Continuity Adjusted Chi-Square	0.295	2	0.863
Likelihood Ratio Chi-Square	0.966	2	0.617
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.146		
Contigency	0.145		
Cramer's V	0.146		
Goodman-Kruskal Gamma	-0.033		0.258
Kendalls tau-b	-0.018		0.142
Stuart's tau-c	-0.020		0.154
Somer's D (C|R)	-0.020		0.155

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Table Statistics for Constructive Enemy Composition			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	2.143	2	0.343
Continuity Adjusted Chi-Square	0.946	2	0.623
Likelihood Ratio Chi-Square	2.178	2	0.336
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.218		
Contigency	0.213		
Cramer's V	0.218		
Goodman-Kruskal Gamma	0.219		0.251
Kendalls tau-b	0.121		0.141
Stuart's tau-c	0.130		0.153
Somer's D (C|R)	0.131		0.153

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Table Statistics for Constructive Combat Power Ratio			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.962	2	0.618
Continuity Adjusted Chi-Square	0.361	2	0.835
Likelihood Ratio Chi-Square	0.963	2	0.618
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.146		
Contigency	0.145		
Cramer's V	0.146		
Goodman-Kruskal Gamma	-0.226		0.246
Kendalls tau-b	-0.126		0.141
Stuart's tau-c	-0.138		0.155
Somer's D (C|R)	-0.139		0.156

Table Statistics for Constructive Task Organization			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	0.402	2	0.818
Continuity Adjusted Chi-Square	0.077	2	0.962
Likelihood Ratio Chi-Square	0.404	2	0.817
Coefficient	Value	Asymptotic Std. Error	
Phi	0.094		
Contigency	0.094		
Cramer's V	0.094		
Goodman-Kruskal Gamma	0.144		0.251
Kendalls tau-b	0.080		0.141
Stuart's tau-c	0.089		0.156
Somer's D (C|R)	0.089		0.157

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Table Statistics for Constructive Enemy Equipment			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	0.100	2	0.951
Continuity Adjusted Chi-Square	0.000	2	1.000
Likelihood Ratio Chi-Square	0.100	2	0.951
Coefficient	Value	Asymptotic Std. Error	
Phi	0.047		
Contigency	0.047		
Cramer's V	0.047		
Goodman-Kruskal Gamma	-0.075		0.244
Kendalls tau-b	-0.043		0.141
Stuart's tau-c	-0.049		0.161
Somer's D (C|R)	-0.050		0.162

Table Statistics for Constructive Friendly Equipment			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	1.164	2	0.559
Continuity Adjusted Chi-Square	0.410	2	0.815
Likelihood Ratio Chi-Square	1.171	2	0.557
Coefficient	Value	Asymptotic Std. Error	
Phi	0.161		
Contigency	0.159		
Cramer's V	0.161		
Goodman-Kruskal Gamma	0.268		0.247
Kendalls tau-b	0.148		0.140
Stuart's tau-c	0.162		0.153
Somer's D (C|R)	0.163		0.153

Table Statistics for Constructive Adjacent Unit			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	1.030	2	0.597
Continuity Adjusted Chi-Square	0.376	2	0.829
Likelihood Ratio Chi-Square	1.034	2	0.596
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.151		
Contigency	0.150		
Cramer's V	0.151		
Goodman-Kruskal Gamma	0.212		0.240
Kendalls tau-b	0.122		0.140
Stuart's tau-c	0.138		0.159
Somer's D (C|R)	0.139		0.160

Table Statistics for Constructive Enemy Training Level			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.981	2	0.612
Continuity Adjusted Chi-Square	0.408	2	0.816
Likelihood Ratio Chi-Square	0.983	2	0.612
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.148		
Contigency	0.146		
Cramer's V	0.148		
Goodman-Kruskal Gamma	0.236		0.237
Kendalls tau-b	0.136		0.140
Stuart's tau-c	0.154		0.158
Somer's D (C|R)	0.155		0.159

Table Statistics for Constructive Enemy Mission			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.773	2	0.680
Continuity Adjusted Chi-Square	0.258	2	0.879
Likelihood Ratio Chi-Square	0.780	2	0.677
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.131		
Contigency	0.130		
Cramer's V	0.131		
Goodman-Kruskal Gamma	0.227		0.252
Kendalls tau-b	0.124		0.140
Stuart's tau-c	0.134		0.152
Somer's D (C|R)	0.135		0.153

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Table Statistics for Constructive Weather			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	1.920	2	0.383
Continuity Adjusted Chi-Square	0.935	2	0.626
Likelihood Ratio Chi-Square	1.938	2	0.379
Coefficient	Value	Asymptotic Std. Error	
Phi	0.207		
Contigency	0.202		
Cramer's V	0.207		
Goodman-Kruskal Gamma	0.082		0.245
Kendalls tau-b	0.047		0.142
Stuart's tau-c	0.053		0.160
Somer's D (C|R)	0.054		0.160

Table Statistics for Constructive Previous Use			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	1.128	2	0.569
Continuity Adjusted Chi-Square	0.256	2	0.880
Likelihood Ratio Chi-Square	1.170	2	0.557
Coefficient	Value	Asymptotic Std. Error	
Phi	0.158		
Contigency	0.156		
Cramer's V	0.158		
Goodman-Kruskal Gamma	0.269		0.265
Kendalls tau-b	0.140		0.140
Stuart's tau-c	0.144		0.146
Somer's D (C|R)	0.145		0.146

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Table Statistics for Constructive Level of Difficulty			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	0.382	2	0.826
Continuity Adjusted Chi-Square	0.057	2	0.972
Likelihood Ratio Chi-Square	0.383	2	0.826
Coefficient	Value	Asymptotic Std. Error	
Phi	0.093		
Contingency	0.093		
Cramer's V	0.093		
Goodman-Kruskal Gamma	0.155		0.259
Kendalls tau-b	0.085		0.143
Stuart's tau-c	0.093		0.157
Somer's D (C|R)	0.093		0.157

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Table Statistics for Constructive Assessment			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	3.980	2	0.137
Continuity Adjusted Chi-Square	2.330	2	0.312
Likelihood Ratio Chi-Square	4.360	2	0.113
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.297		
Contigency	0.285		
Cramer's V	0.297		
Goodman-Kruskal Gamma	0.604	0.263	
Kendalls tau-b	0.268	0.129	
Stuart's tau-c	0.229	0.117	
Somer's D (C|R)	0.230	0.117	

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Table Statistics for Constructive Light Data			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	1.132	2	0.568
Continuity Adjusted Chi-Square	0.503	2	0.778
Likelihood Ratio Chi-Square	1.138	2	0.566
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.159		
Contigency	0.157		
Cramer's V	0.159		
Goodman-Kruskal Gamma	0.257	0.231	
Kendalls tau-b	0.149	0.138	
Stuart's tau-c	0.172	0.159	
Somer's D (C|R)	0.173	0.160	

Table Statistics for Constructive Observation Devices			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	1.073	2	0.585
Continuity Adjusted Chi-Square	0.410	2	0.815
Likelihood Ratio Chi-Square	1.072	2	0.585
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.153		
Contigency	0.151		
Cramer's V	0.153		
Goodman-Kruskal Gamma	0.214	0.240	
Kendalls tau-b	0.122	0.139	
Stuart's tau-c	0.136	0.156	
Somer's D (C|R)	0.137	0.157	

Table Statistics for Constructive Exercise Planning			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	1.845	2	0.397
Continuity Adjusted Chi-Square	0.733	2	0.693
Likelihood Ratio Chi-Square	1.876	2	0.391
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.202		
Contigency	0.198		
Cramer's V	0.202		
Goodman-Kruskal Gamma	0.149		0.265
Kendalls tau-b	0.079		0.142
Stuart's tau-c	0.083		0.149
Somer's D (C|R)	0.083		0.150

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Table Statistics for Constructive Mission Planning			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	2.086	2	0.352
Continuity Adjusted Chi-Square	0.950	2	0.622
Likelihood Ratio Chi-Square	2.125	2	0.346
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.215		
Contigency	0.210		
Cramer's V	0.215		
Goodman-Kruskal Gamma	0.000		0.255
Kendalls tau-b	0.000		0.143
Stuart's tau-c	0.000		0.156
Somer's D (C|R)	0.000		0.157

Table Statistics for Virtual Terrain			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	3.830	2	0.147
Continuity Adjusted Chi-Square	2.228	2	0.328
Likelihood Ratio Chi-Square	4.083	2	0.130
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.341		
Contigency	0.322		
Cramer's V	0.341		
Goodman-Kruskal Gamma	-0.545		0.242
Kendalls tau-b	-0.300		0.154
Stuart's tau-c	-0.309		0.163
Somer's D (C|R)	-0.309		0.163

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Table Statistics for Virtual Task			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	2.443	2	0.295
Continuity Adjusted Chi-Square	1.101	2	0.577
Likelihood Ratio Chi-Square	2.473	2	0.290
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.272		
Contigency	0.263		
Cramer's V	0.272		
Goodman-Kruskal Gamma	-0.420	0.253	
Kendalls tau-b	-0.245	0.159	
Stuart's tau-c	-0.272	0.177	
Somer's D (C|R)	-0.272	0.177	

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Table Statistics for Virtual Simulator			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	3.759	2	0.153
Continuity Adjusted Chi-Square	1.996	2	0.369
Likelihood Ratio Chi-Square	3.842	2	0.146
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.337		
Contigency	0.320		
Cramer's V	0.337		
Goodman-Kruskal Gamma	-0.543	0.228	
Kendalls tau-b	-0.319	0.154	
Stuart's tau-c	-0.349	0.169	
Somer's D (C|R)	-0.349	0.169	

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Table Statistics for Virtual Friendly Composition			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	5.165	2	0.076
Continuity Adjusted Chi-Square	3.140	2	0.208
Likelihood Ratio Chi-Square	5.578	2	0.061
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.396		
Contigency	0.368		
Cramer's V	0.396		
Goodman-Kruskal Gamma	-0.097	0.280	
Kendalls tau-b	-0.058	0.169	
Stuart's tau-c	-0.066	0.192	
Somer's D (C|R)	-0.066	0.192	

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Table Statistics for Virtual Enemy Composition			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	0.503	2	0.777
Continuity Adjusted Chi-Square	0.038	2	0.981
Likelihood Ratio Chi-Square	0.506	2	0.776
Coefficient	Value	Asymptotic Std. Error	
Phi	0.124		
Contigency	0.123		
Cramer's V	0.124		
Goodman-Kruskal Gamma	0.114		0.297
Kendalls tau-b	0.063		0.166
Stuart's tau-c	0.070		0.183
Somer's D (C|R)	0.070		0.183

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Table Statistics for Virtual Combat Power Ratio			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	0.795	2	0.672
Continuity Adjusted Chi-Square	0.204	2	0.903
Likelihood Ratio Chi-Square	0.798	2	0.671
Coefficient	Value	Asymptotic Std. Error	
Phi	0.155		
Contigency	0.153		
Cramer's V	0.155		
Goodman-Kruskal Gamma	-0.180		0.277
Kendalls tau-b	-0.105		0.164
Stuart's tau-c	-0.121		0.189
Somer's D (C|R)	-0.121		0.189

Table Statistics for Virtual Task Organization			
Test Statistic	Value	DF	Prob.
Pearson Chi-Square	0.847	2	0.655
Continuity Adjusted Chi-Square	0.217	2	0.897
Likelihood Ratio Chi-Square	0.853	2	0.653
Coefficient	Value	Asymptotic Std. Error	
Phi	0.160		
Contigency	0.158		
Cramer's V	0.160		
Goodman-Kruskal Gamma	-0.184		0.281
Kendalls tau-b	-0.106		0.164
Stuart's tau-c	-0.121		0.187
Somer's D (C|R)	-0.121		0.187

Table Statistics for Virtual Enemy Equipment			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.081	2	0.960
Continuity Adjusted Chi-Square	0.000	2	1.000
Likelihood Ratio Chi-Square	0.081	2	0.960
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.050		
Contigency	0.049		
Cramer's V	0.050		
Goodman-Kruskal Gamma	0.000		0.286
Kendalls tau-b	0.000		0.165
Stuart's tau-c	0.000		0.189
Somer's D (C|R)	0.000		0.189

Table Statistics for Virtual Friendly Equipment			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.763	2	0.683
Continuity Adjusted Chi-Square	0.187	2	0.911
Likelihood Ratio Chi-Square	0.766	2	0.682
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.152		
Contigency	0.150		
Cramer's V	0.152		
Goodman-Kruskal Gamma	0.225		0.284
Kendalls tau-b	0.128		0.164
Stuart's tau-c	0.143		0.183
Somer's D (C|R)	0.143		0.184

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Table Statistics for Virtual Adjacent Unit			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.249	2	0.883
Continuity Adjusted Chi-Square	0.008	2	0.996
Likelihood Ratio Chi-Square	0.249	2	0.883
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.087		
Contigency	0.087		
Cramer's V	0.087		
Goodman-Kruskal Gamma	0.000		0.285
Kendalls tau-b	0.000		0.164
Stuart's tau-c	0.000		0.189
Somer's D (C|R)	0.000		0.189

Table Statistics for Virtual Enemy Training Level			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	5.852	2	0.054
Continuity Adjusted Chi-Square	3.476	2	0.176
Likelihood Ratio Chi-Square	7.789	2	0.020
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.421		
Contigency	0.388		
Cramer's V	0.421		
Goodman-Kruskal Gamma	0.058		0.298
Kendalls tau-b	0.034		0.172
Stuart's tau-c	0.037		0.189
Somer's D (C|R)	0.037		0.189

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Table Statistics for Virtual Enemy Mission			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.061	2	0.970
Continuity Adjusted Chi-Square	0.000	2	1.000
Likelihood Ratio Chi-Square	0.061	2	0.970
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.043		
Contigency	0.043		
Cramer's V	0.043		
Goodman-Kruskal Gamma	0.065		0.296
Kendalls tau-b	0.036		0.165
Stuart's tau-c	0.040		0.184
Somer's D (C|R)	0.040		0.184

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Table Statistics for Virtual Weather			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	1.625	2	0.444
Continuity Adjusted Chi-Square	0.653	2	0.722
Likelihood Ratio Chi-Square	1.643	2	0.440
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.222		
Contigency	0.217		
Cramer's V	0.222		
Goodman-Kruskal Gamma	0.071		0.285
Kendalls tau-b	0.042		0.168
Stuart's tau-c	0.048		0.192
Somer's D (C|R)	0.048		0.192

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Table Statistics for Virtual Previous Use			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.335	2	0.846
Continuity Adjusted Chi-Square	0.018	2	0.991
Likelihood Ratio Chi-Square	0.336	2	0.845
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.101		
Contigency	0.100		
Cramer's V	0.101		
Goodman-Kruskal Gamma	-0.122		0.298
Kendalls tau-b	-0.067		0.166
Stuart's tau-c	-0.073		0.181
Somer's D (C|R)	-0.074		0.181

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Table Statistics for Virtual Level of Difficulty			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	1.625	2	0.444
Continuity Adjusted Chi-Square	0.653	2	0.722
Likelihood Ratio Chi-Square	1.643	2	0.440
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.222		
Contigency	0.217		
Cramer's V	0.222		
Goodman-Kruskal Gamma	-0.301		0.265
Kendalls tau-b	-0.177		0.162
Stuart's tau-c	-0.202		0.184
Somer's D (C|R)	-0.202		0.185

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Table Statistics for Virtual Assessment			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	1.925	2	0.382
Continuity Adjusted Chi-Square	0.307	2	0.668
Likelihood Ratio Chi-Square	2.051	2	0.359
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.242		
Contigency	0.235		
Cramer's V	0.242		
Goodman-Kruskal Gamma	0.495		0.333
Kendalls tau-b	0.214		0.157
Stuart's tau-c	0.180		0.138
Somer's D (C|R)	0.180		0.138

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Table Statistics for Virtual Light Data			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	0.795	2	0.672
Continuity Adjusted Chi-Square	0.204	2	0.903
Likelihood Ratio Chi-Square	0.798	2	0.671
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.155		
Contigency	0.153		
Cramer's V	0.155		
Goodman-Kruskal Gamma	-0.180		0.277
Kendalls tau-b	-0.105		0.164
Stuart's tau-c	-0.121		0.189
Somer's D (C|R)	-0.121		0.189

Table Statistics for Virtual Observation Devices			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	2.524	2	0.283
Continuity Adjusted Chi-Square	1.245	2	0.537
Likelihood Ratio Chi-Square	2.560	2	0.278
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.277		
Contigency	0.267		
Cramer's V	0.277		
Goodman-Kruskal Gamma	-0.404		0.246
Kendalls tau-b	-0.242		0.158
Stuart's tau-c	-0.279		0.182
Somer's D (C|R)	-0.279		0.182

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Table Statistics for Virtual Exercise Preparation			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	4.212	2	0.122
Continuity Adjusted Chi-Square	2.821	2	0.244
Likelihood Ratio Chi-Square	4.325	2	0.115
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.357		
Contigency	0.336		
Cramer's V	0.357		
Goodman-Kruskal Gamma	0.573		0.217
Kendalls tau-b	0.343		0.155
Stuart's tau-c	0.375		0.169
Somer's D (C|R)	0.375		0.169

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Table Statistics for Virtual Mission Planning			
Test Statistic	**Value**	**DF**	**Prob.**
Pearson Chi-Square	3.383	2	0.184
Continuity Adjusted Chi-Square	1.895	2	0.388
Likelihood Ratio Chi-Square	3.499	2	0.174
Coefficient	**Value**	**Asymptotic Std. Error**	
Phi	0.320		
Contigency	0.305		
Cramer's V	0.320		
Goodman-Kruskal Gamma	0.161		0.275
Kendalls tau-b	0.096		0.166
Stuart's tau-c	0.110		0.190
Somer's D (C|R)	0.110		0.190

Warning: More than 1/5 of Fitted Cells are Sparse

REFERENCES

Adler, M. & Ziglio, E. (1996). Gazing into the Oracle. Bristol, PA: Jessica Kingsley Publishers.

Anderson, J. (1993). Rules of the Mind. Hillsdale, NJ: Lawrence Erlbaum Associates Publishers.

Ayers, F. (1962). Theory and Outline of Matrices. NY: McGraw-Hill Book Company.

Barrett, Raymond, Chief of Staff, 24th Infantry Division, FT Stewart (Telephone Interview, August, 1996).

Battle Focused Training. (1990). Washington, DC. Department of the Army.

Berk, K. N. & Carey, P. (1995). Data Analysis with Microsoft Excel 5.0 for Windows [Computer software]. Boston, MA: Course Technology.

Beyth-Marom, R. (1982). How Probable is Probable? A Numerical Translation of Verbal Probability Expressions. Journal of Forecasting, I, 257-259.

Brann, J., LORAL Federal Systems, Orlando Florida (Distributed Interactive Simulation Protocols. Class presentation, November 1995).

Cochran, W. G. (1977). Sampling Techniques. NY: Wiley.

Combat Simulation Laboratory. (Undated). User's Manual: Janus 5.X-UNIX Model. West Point:: NY. United States Military Academy.

Createau, K., National Training Center Desk Officer, Combat Training Center Directorate (Personal Interview, February 1997).

Czaja, R., & Blair, J. (1996). Designing Surveys. Thousand Oaks, CA: Pine Forge.

Delbecq, A., Van de Van, A. & Gustafson, D. (1975). Group Techniques for Program Planning. Glenview, IL: Scott, Foresman and Company.
Department of the Army. (August 1996). Fire Coordination Exercise, Training Circular No. 71-5 [On line]. Available: http://www.entelechy-inc.com/doc/knoxsdoc/tc71-5-0814/c1.htm

Department of the Army. (February, 1998). ARTEP 7-30-MTP, Fort Benning: GA.

Department of the Army. (December, 1991). TO&E Handbook Infantry Battalion, Infantry Division, Fort Benning: GA.

Durkin, J. (1994). Expert Systems Design and Development. NY: MacMillan Publishing Company.

Fink, A. (1995). How to Analyze Survey Data, The Survey Kit. Thousand Oaks, CA: Sage Publications.

Fink, A. (1995). How to Ask Surveys Questions, The Survey Kit. Thousand Oaks, CA: Sage Publications.

Fink, A., (1995). How to Report on Surveys, The Survey Kit. Thousand Oaks, CA: Sage Publications.

Fink, A., (1995). The Survey Handbook., The Survey Kit. Thousand Oaks, CA: Sage Publications.

Gorman, P. F. (1991). The Future of Tactical Engagement Simulation. Proceedings of the 1991 Summer Computer Simulation Conference, 1181-1186.

Headquarters US Army Simulation, Training, and Instrumentation Command (STRICOM). (1995). Task Performance Support (TPS) Codes. (Contract No. N61339-92-D-0018). Orlando, FL: Sherikon.

Hollenbach, J. (1995). Deputy Director, Defense Modeling and Simulation Office. The High Level Architecture. [On-line]. Available: http://www.dmso.mil

Institute of Defense Analysis (1992, June). A Review of Study Panel Recommendations for Defense Modeling Simulation, (IDA Document D-1161) Alexandria VA: Fletcher J. D.

Institute of Defense Analysis (1992, February). The Secret of Future Victories (IDA Paper P-2653). Alexandria, VA: Gorman.

Institute of Defense Analysis (1994, September). The Value of Simulation for Training, (IDA Paper P-2982). Alexandria, VA: Orlansky.

Kotnour, T. (1992). Design, Development, and Testing of an Automated Knowledge Acquisition Tool to Aid Problem Solving, Decision Making, and Planning. Blacksburg, VA: Author.

Labaw, P. J. (1980). Advanced Questionnaire Design. Cambridge, MA: Abt Books.

La Rouque, R. Director of the National Simulation Center (Personal Interview, September 1996).

Lehtonen, R. & Pahkinen, E. (1995). Practical Methods for Design and Analysis of Complex Surveys. NY: John Wiley and Sons.

Malone, L., Associate Professor, University of Central Florida (Personal Interview, November 1996).

Minitab 10x [Computer software]. (1995). State College, PA: Minitab.

National Training Systems Association. (1997). Return on Investment [On-line]. Available: http://www.adpa.org/ntsa/benefits/roi/index.htm

Orgaization of the Army in the Field. (May 1991). Fort Leavenworth, KS: U.S. Army Command and General Staff College.

Piplani, L., Mercer, J., & Roop, R. (1994). Systems Acquisition Manager's Guide for the Use of Models and Simulations. Ft. Belvoir, VA: Defense Systems Management College Press.

Rossi, Michael, Chief, G-3 Training, 101st Airborne Division (Air Assault) (Personal Interview, October, 1996).

Soviet Army Equipment, Organization, and Operations. (May 1991). Fort Leavenworth, KS: U.S. Army Command and General Staff College.

Staff Skills, Roles and Relationships. (May 1991). Fort Leavenworth, KS: U.S. Army Command and General Staff College.

Stone, G. F. (1996). The Use of Computer-based Planning to Enhance the Effectiveness and Efficiency of Simulation-based Team Training. Published doctoral dissertation, University of Central Florida, Orlando.

Training Management. (May 1991). Fort Leavenworth, KS: U.S. Army Command and General Staff College.

United States Army Research Institute. (1993, May). Commander's Battle Staff, Ft. Benning, GA.

Welbank, M. (1990). An Overview of knowledge acquisition methods. Interacting with Computers, 2 (1). (83-91).

Williams, K. University of Central Florida, Orlando Florida (Cognitive Task Analysis, November 1995).